Potential for Renewable Energy Development: Alternatives to AEO2001

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Preface

The U.S. Department of Energy's Energy Information Administration (EIA) has developed a comprehensive computer model of the domestic energy economy that it employs to forecast possible scenarios of energy development within the U.S. including production, imports, conversion, consumption and price. This model, called the National Energy Modeling System (NEMS) incorporates economic, regulatory, resource, technological and environmental data on all aspects of energy development and consumption in the United States. The results of Reference Case simulations using NEMS are published in the *Annual Energy Outlook* (AEO). Planners and decision-makers in both the public and private sectors refer to forecasts produced by NEMS for analysis of policy initiatives.

The reference case projections of the AEO assume continuing market changes and improvement in energy technologies as derived from past trends. Under these conditions, renewable energy technologies have typically not achieved significant market share during the AEO forecast period. This report explores some of the assumptions used in NEMS regarding renewable electric-generation technologies to determine how modifying these assumptions might influence the projected growth of these technologies.

Acknowledgements

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List of Acronyms

AEO Annual Energy Outlook

COE Cost of Energy

CHP Combined Heat and Power DOE U.S. Department of Energy

EIA Energy Information Administration

GPRA Government Performance and Results Act

LFG Landfill Gas

MSW Municipal Solid Waste

NEMS National Energy Modeling System OPT Office of Power Technologies

PERI Princeton Energy Resources International

PTC Production Tax Credit

PV Photovoltaic

RETC 1997 Renewable Energy Technology Characteristics

RPS Renewable Portfolio Standards

Executive Summary

Levelized cost of energy assumptions for renewable energy technologies significantly influence forecast projections of U.S. grid-connected power generation and associated carbon emissions. Assumptions that are based on cost alone ignore the potential of other factors, such as direct access and green marketing, to drive capacity expansion. In recent years, deregulation has enabled consumers in many states to purchase electricity from renewable sources, even if it is not the least-cost option. Capacity expansion decisions in the National Energy Modeling System (NEMS) are primarily determined by factors directly affecting the cost of energy. NEMS is a commonly referenced computer model of the U.S. energy-economy that is used by the U.S. Department of Energy to produce the *Annual Energy Outlook* and its projections through 2020. In NEMS, renewable energy technologies fail to capture a significant share of the electricity market, even by the end of the forecast period.

This study explores the potential impact of green marketing-supported electric-generator capacity additions and alternative cost of energy assumptions for renewable energy technologies on the overall cost and development of renewable grid-connected power generation in a modified version of NEMS. The expectation is that policies and programs designed to increase market share will leverage economies of scale and learning by doing that will in turn help reduce the cost of these technologies, making them more cost-competitive in the long run with currently established technologies.

Seven simulations were conducted using a modified version of the Energy Information Administration's National Energy Modeling System (NEMS-GPRA)¹ (Table ES-1). Results are compared to the *Annual Energy Outlook 2001* (AEO2001) Reference Case for six renewable energy technologies. For each of these scenarios, the renewable energy technologies considered were geothermal, biomass, solar thermal, solar photovoltaic, wind and municipal solid waste (excluded in the levelized cost scenarios).

In the first scenario (FX), technical fixes were applied to the wind and intermittent technologies to improve their treatment by the model. The second case (RA) augmented the forced capacity additions for each technology. This case was designed to represent the probable outcome of a green pricing market in which construction of renewable generation is increased to serve consumer demand for clean power. Input capacity additions were supplied by Princeton Energy Resources International (PERI) based on their green market analysis for the U.S. Department of Energy's Office of Power Technologies (DOE/OPT, 2001b). The third scenario (TC) modified the levelized cost of energy for each technology. This case represents the competitive outcome of more aggressive projections of technological progress for renewable energy technologies. The alternative costs of energy assumptions were based on the *1997 Renewable Energy Technology Characterizations* (RETC).² For all of the above technologies, with the exception of biomass, the

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¹ For clarity, the modified version of NEMS as used for this analysis is referred to as NEMS-GPRA, to denote the Government Performance and Results Act (GPRA) focus of this study.

² The RETC is the result of a joint project of EPRI and the DOE/OPT that assesses the current capabilities and future potential of renewable electric generation technologies. It includes projections of future performance and costs,

forecast in the RETC results in a reduced levelized cost of renewable energy than predicted in the AEO2001 Reference Case. A fourth scenario (HP) augmented industrial as well as commercial sector combined heat and power (CHP) capacities. A doubled natural gas price case (NG) is explored as a sensitivity case on the model to identify the potential benefits to renewables. The sixth scenario (WN) looks at the enhancement of lower wind speed technologies under a proposed \$40 million wind research budget. Finally, a combination of these six scenarios (AL) was run in which the code fixes, green pricing additions, cost of energy modifications, CHP adjustments, high gas price, and enhanced lower wind speed technologies were implemented.

Table ES-1. NEMS-GPRA Analysis Scenarios

Case #	Abb.	Title	Description
Case 0		NEMS-GPRA reference case	Replication of AEO2001
Case 1	FX	Technical fixes	Adjustments to wind and intermittent
			technologies
Case 2	RA	Renewable additions	Forced capacity additions for six
			renewable technologies based on green
			pricing forecasts by PERI
Case 3	TC	Technology characterization	Modified cost of energy parameters based
			on RETC for five renewable technologies
Case 4	HP	Combined heat and power	Adjustments to increase natural gas and
			biomass CHP in the industrial and
			commercial sectors
Case 5	NG	High natural gas price	Apply a carbon tax to natural gas prices
			to individual sectors to produce a doubled
			effect by 2020
Case 6	WN	Wind cost sensitivity	Modify cost of energy parameters for
			wind to match \$40 million wind research
			budget cost projection
Case 7	AL	Scenario combination	Cases 1 through 6 combined

Results from each of the scenarios, as summarized in Table ES-2, demonstrate a substantial increase in renewable electric power capacity and generation as well as a significant reduction in carbon emissions for each of the scenarios. The total installed capacity in 2020 of non-hydro renewable electricity generators is shown in Figure ES-1. Generally, the AL case produced the most dramatic results, although individual technologies were affected differently in each case. Wind development received the greatest boost from the modifications to NEMS-GPRA.

For all technologies, the Case 7 AL resulted in an increase in generation that was greater than any of the individual scenarios, but less than their sum. Wind, which has a comparatively low cost of energy in the RETC, experienced an increase in generation in the AL case over 20 times

including levelized energy cost estimates, based on the assumption of continued developmental support and successful resolution of unresolved issues.

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that of the reference case by 2020. Geothermal was up 2.5 times and solar thermal up 2.8 times over the reference case by 2020 in the AL Case 7. In the TC case, the forecast for photovoltaic, with its relatively high cost of energy, did not change in the TC case 3, but generation did increase by 93% in 2020 in both the RA and AL cases. The projection for MSW, a 5.6% increase by 2020, for the RA and 13.3% increase in 2020 under the AL case is likely due to the high natural gas influence.

In each scenario, carbon emissions decreased in comparison to the reference case every year between 2001 and 2020. By 2020, electricity sector emissions were only slightly lower in the FX case, down 4 Mt/a (0.2%) in RA, 28 Mt/a (1.4%) in TC, 4 Mt/a (0.2%) in HP, 9 Mt/a (0.4%) in NG, 33 Mt/a (1.6%) in WN, and 62 Mt/a (3.0%) in the combined scenario.

Table ES-2. Capacity, Generation, Carbon, and CHP Changes for 2020 (and 2010), Cases 1-7

	Renewable Capacity (GW)	Renewable Generation (TWh)	Carbon Emissions (Mt)
Case 1 (FX)	0.5 (0.6)	1.5 (2.4)	0 (1.0)
Case 2 (RA)	7.2 (3.4)	25.1 (11.6)	-4 (-3)
Case 3 (TC)	50.5 (15.9)	199.8 (74.4)	-28 (-14)
Case 4 (HP)	0.0 (0.0)	0.0 (0.4)	-4 (-5)
Case 5 (NG)	1.7 (0.3)	4.5 (4.8)	-9 (-16)
Case 6 (WN)	62.9 (18.7)	261.9 (81.4)	-33 (-12)
Case 7 (AL)	76.2 (24.5)	309.1 (108.3)	-62 (-36)

XIII

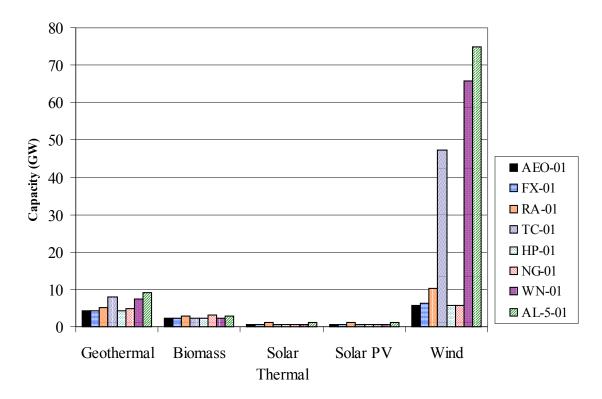


Figure ES-1. Total Non-Hydro Renewable Capacity in 2020 by Technology

1. Introduction

Forecasts of the potential market for renewables are highly dependent on assumptions regarding future technology and policy developments. Technological optimism will govern projections of the economic competitiveness of renewable technologies by influencing factors that are included in a technology's levelized cost of energy equation. Policy mechanisms exist or may be created to help increase market share for various nascent technologies, based on externalities that the electricity market, in its current state, fails to internalize. Features of renewable technologies that argue for policies to encourage their continued growth and development include: they are well suited for decentralized generation; they have the potential to supply an abundant domestic source of power; they can provide non-polluting, carbon neutral energy. This study explores the potential impact of technology and policy advancements that enhance the economic competitiveness of renewable technologies.

In the National Energy Modeling System (NEMS), as with many models, levelized cost of energy assumptions for renewable energy technologies significantly influence forecast projections of U.S. grid-connected power generation and associated carbon emissions. The NEMS Reference Case assumes that only state renewable portfolio standards (RPS) programs that are currently legislated will support capacity additions for renewables outside of these technologies becoming a least-cost option. The possibility of direct access for consumers and green marketing of renewables under deregulation is not modeled explicitly. Instead, factors affecting cost of energy function as the primary driver of capacity expansion decisions. In the resulting forecasts, which extend through 2020 for the *Annual Energy Outlook 2001* (AEO2001), renewable energy technologies fail to capture a significant share of the electricity market.

This study explores the effect of seven scenarios on overall cost and development of renewable grid-connected power generation in a modified version of the Energy Information Administration's National Energy Modeling System (NEMS). The impacts of these alternative forecasts are compared to the AEO2001 Reference Case for installed capacity, generation and carbon emissions for six renewable energy technologies. For each of these scenarios, the renewable energy technologies considered were geothermal, biomass, solar thermal, solar photovoltaic (PV), wind and municipal solid waste (excluded in the levelized cost scenarios).

Table 1 summarizes the eight cases that were executed for this analysis. These scenarios include a reference case (Case 0); a technical fix case (Case 1); a renewable capacity additions case based on green marketing projections (Case 2); a technology optimism case based on alternative cost of energy assumptions for renewables (Case 3); a combined heat and power case for the industrial and commercial sectors (Case 4); a high natural gas price scenario (Case 5); a wind sensitivity case based on enhancements to lower wind speeds under a proposed \$40 million wind research budget (Case 6); and a combined scenario with all of these changes incorporated (Case 7).

The first scenario incorporates changes to wind policy and modifications to the level of allowable intermittent technologies. The second case, which augments the forced capacity additions for each technology, represents the probable outcome of a green pricing market in which construction of renewable generation is increased to serve consumer demand for clean

power. The third scenario, modifies the levelized cost of energy for each technology, representing the competitive outcome of more aggressive projections of technological progress for renewable energy technologies. The fourth scenario increases the AEO2001 assumptions regarding the potential for combined heat and power (CHP) in industrial applications with some treatment of commercial CHP capabilities. The fifth case doubles price of natural gas to observe its potential benefits to renewable technologies. A sixth case looks at how the low wind speed technologies would benefit under varying wind research budgets with a focus on the \$40 million funding scenario. Finally, a combination of these six scenarios is executed in which the code fixes, green pricing additions, cost of energy modifications, CHP adjustments, high natural gas price, and wind enhancements were implemented.

Table 1. NEMS-GPRA Analysis Cases

Case #	Abb.	Title	Description
Case 0		NEMS-GPRA reference case	Replication of AEO2001
Case 1	FX	Technical fixes	Adjustments to wind and intermittent
			technologies
Case 2	RA	Renewable additions	Forced capacity additions for six
			renewable technologies based on green
			pricing forecasts by PERI
Case 3	TC	Technology characterization	Modified cost of energy parameters based
			on RETC for five renewable technologies
Case 4	HP	Combined heat and power	Adjustments to increase generation and
			capacity for industrial biomass and
			natural gas and natural gas commercial
			CHP
Case 5	NG	High natural gas price	Apply a carbon tax to natural gas prices
			to individual sectors
Case 6	WN	Wind cost sensitivity	Modify cost of energy parameters for
			wind to match \$40 million wind research
			budget cost projection
Case 7	AL	Scenario combination	Cases 1 though 6 combined

2. Methodology

Berkeley Lab has developed a derivation of the EIA version of NEMS that permits the manipulation of key economic drivers of renewable energy development. For clarity, this modified version of NEMS is referred to as NEMS-GPRA. With NEMS-GPRA it is possible to test the effects of changes in energy cost and forced capacity assumptions for renewables compared to the Reference Case projections published in AEO2001. The sensitivity of the model is such that, for some technologies, relatively small differences in forecast cost of energy parameters can significantly affect electricity generation and carbon emissions projections.

The changes for the FX Case 1 enhance the capabilities of intermittent technologies and promote the growth of wind. The forced capacity additions in the RA Case 2 were derived as part of a green marketing analysis conducted by Princeton Energy Resources International (PERI) for DOE's Office of Power Technologies (2001b). The alternative costs of energy assumptions in the TC case were based on the 1997 Renewable Energy Technology Characterizations (RETC).³ The HP source code and input changes were supplied by PERI based on work for DOE/OPT (2001a). The high natural gas prices in the NG case simulate the effects of doubled gas prices by 2020. The WN case was derived by PERI to determine how a \$40 million budget for the wind program would impact the forecast for renewables, especially wind. The AL case determines the effectiveness of integrating the various case changes.

The modifications for each scenario are outlined in the following seven sections. The reference Case 0 is the NEMS-GPRA version of the AEO2001 Reference Case. This case contains no code or data changes. Any deviations from the results published in AEO2001 and those reported here for Case 0 are a result of compiler and processor differences between EIA and Berkeley Lab platforms. This case serves as baseline against which all other cases are compared.

2.1 **Case 1: Technical Fixes (FX)**

Modifications to the reference case were implemented to improve its treatment of renewable energy technologies. FX Case 1 incorporates changes to wind and intermittent technologies as follows:

Wind

- extend the production tax credit to wind plants built by 2006 - update last year of generation

3

subsidy variable ("UPIRGSYL") in ecpdat input file to 2006 from 2001 and increase the magnitude of the subsidy to adjust for the fact that the credit is a deduction from tax owed (after-tax). Therefore, its value before tax (as it is treated in the model, like a negative O&M cost) should be the credit/(1-tax rate).

³ The RETC is the result of a joint project of EPRI and the Department of Energy's Office of Utility Technologies that characterizes the current state of the most competitive renewable energy technologies and projects the cost of energy for these technologies 30 years into the future, based on the assumption of continued developmental support and successful resolution of unresolved issues.

- Intermittent technologies
 - <u>increase the upper limit of intermittent renewable technologies</u> (solar thermal, solar PV, and wind) raise the allowable penetration to 50% of generation in a region from 10% in the *ecpdat* input file.

The impact of these changes is to improve the market responsiveness of these technologies and prevent low ceilings on potential capacity from masking the results of the scenarios tested in this analysis.

2.2 Case 2: Renewable Additions (RA)

The RA Case 2 is intended to represent a possible green pricing scenario, where new market opportunities not currently incorporated in NEMS may significantly impact the growth of renewable electricity generation. In this case, regional renewable capacity additions were forced in NEMS-GPRA to reflect the green pricing market. Otherwise all assumptions were kept as close as possible to the reference case.

Table 2. Green Pricing Renewable Capacity Additions, Cases 2 and 7

All Renewables ¹ (MW)	2005	2009	2013	2018	Cumulative
Geothermal	113.7	147.5	254.1	178.8	694.1
LFG	68.5	69.4	70.0	63.8	271.7
Direct-Fired Biomass	46.8	43.1	76.1	46.9	212.9
Biomass Gasification	81.3	79.1	118.2	59.9	338.4
Solar Thermal	38.6	170.2	259.2	140.7	608.7
Concentrator PV	12.7	39.4	96.4	93.0	241.5
Central Station PV	0.0	91.1	185.9	136.3	413.3
Wind class 4	1,318.7	1,098.9	1,553.9	490.7	4,462.1
Total	1,680.2	1,738.6	2,613.8	1,210.0	7,242.6

Although presented as national totals, additions were made regionally, according to the 29 August 2001 PERI spreadsheet

source: Princeton Energy Resources International, spreadsheet from Jim McVeigh 29 August 2001

Table 2 shows the RA and AL planned capacity addition assumptions. These data, based on regional estimates by PERI, were included in the NEMS-GPRA plant data file as planned additions. Each new capacity addition was made by creating a contrived power station with the RETC operating characteristics for that particular renewable technology. New plants for each technology, except biomass and geothermal, were added to the *pltf860* input file. Biomass and geothermal additions were made in a separate input file, called *wfloors*, due to difficulties in implementing them via the *pltf860* file.

Plant sizes were based on PERI (2001b), which reported values as five-year increments (2003, 2008, 2013, and 2018). For all renewables, values were partitioned into annual increments by Berkeley Lab and implemented accordingly. Characteristics of the power stations were revised accordingly each year an addition was made. Solar thermal trough assumptions were used in

2005 and power tower plant assumptions were used for subsequent additions. Solar PV assumptions were those of thin film for all years additions were made. All of the wind capacity additions were from class 4. MSW additions were made as landfill gas (LFG) plants. Generally, these parameters were the lowest cost options in each of the years, with the exception of wind, for which the amount of class 6 resource available in later years was assumed to be limited.

NEMS-GPRA treats the country as comprising 15 Electricity Supply Regions, 13 of which cover the contiguous U.S. (Figure 1). In the regional breakdown of NEMS-GPRA, regions 14 and 15 are combined and reported together with region 13. The forced capacity additions for this case were actually added regionally, according to PERI's projections, but are reported in Table 2 as national totals.

The accuracy of the forced additions was verified by the reported cumulative planned additions, which NEMS-GPRA tallies in a table comparable to Table A17 of AEO2001. The difference in total planned additions in 2020 between the AEO2001 and RA forecasts is 7.2 GW, as expected. The difference in all the intermediate years' totals also agree, indicating that the forced builds were correctly implemented.

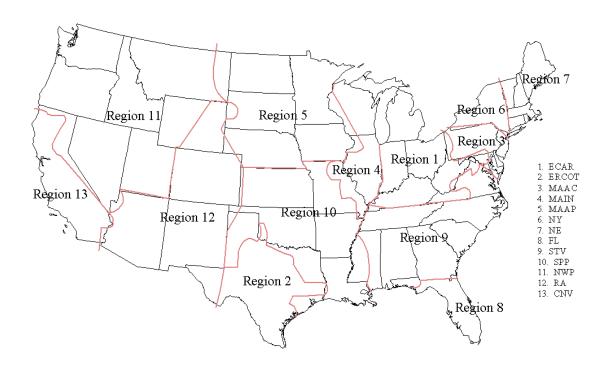


Figure 1. NEMS Electricity Supply Regions

adapted from The National Energy Modeling System: An Overview, Energy Information Administration

2.3 Case 3: Technology Characterization (TC)

The levelized costs implemented in the TC and AL cases are reported in Table 3 and Figure 2 and compared to the levelized costs embedded in AEO2001. These numbers were originally derived from the RETC⁴ and then implemented in NEMS-GPRA, and have an effect similar to that of the AEO2001 "High Renewables" Case. Reported here are the actual levelized costs that are outputted by NEMS-GPRA. The reported costs vary slightly from the values published in RETC because of variation inherent in the method by which they are added to the model, as described below.

	Geoth	ermal	Bio	nass	Solar T	`hermal	Sola	r PV	W	ind
Year	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3	Case 0	Case 3
2001	4.93	4.24	5.41	5.82	15.94	14.67	25.69	24.77	6.15	2.26
2005	4.62	4.03	5.12	5.29	14.65	11.96	17.23	15.47	5.40	3.42
2010	4.94	5.02	5.01	5.55	15.48	10.04	15.69	12.83	5.30	3.48
2015	4.89	4.78	4.77	5.39	14.64	8.53	14.42	10.48	4.74	3.54
2020	5.03	5.13	4.91	5.29	14.11	7.91	14.27	9.05	4.39	3.51

Table 3. Levelized Costs of Energy (1999 ¢/kWh) in Case 0 and Case 3

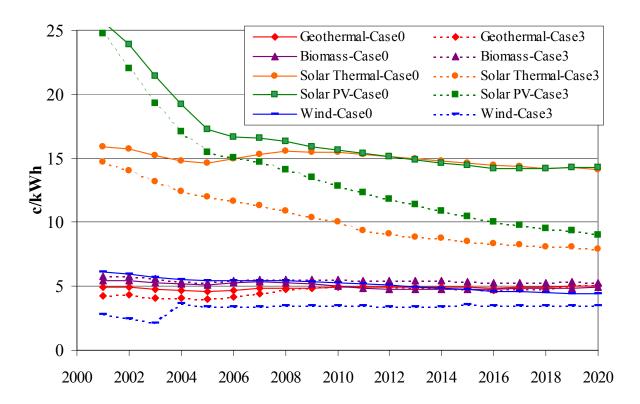


Figure 2. Comparison of Case 0 and Case 3 Levelized Cost of Energy (1999 ¢/kWh)

were taken nom

⁴Values were taken from Chapter 7, *Table 1. Levelized Cost of Energy for GenCo Ownership*, page 7-3.

The RETC levelized costs were incorporated in NEMS-GPRA by overwriting the capital and fixed O&M costs directly. The capital costs and fixed O&M costs for each technology (solar PV, wind, solar thermal, geothermal and biomass) in NEMS-GPRA Case 3 reflects the RETC forecast. These costs are overwritten in the *ecpdat* input file. The levelized costs that result from lowered capital and fixed O&M costs for Case 3 (as output by NEMS-GPRA) are reported in appendix Table 2TC, as compared to the levelized costs embedded in Case 0. Differences between the RETC and NEMS-GPRA levelized costs of energy are due to the way NEMS models the overwritten cost changes and how they affect other variables that contribute to the levelized cost calculation. As well, differences in the assumed fixed charge factor also account for some of the discrepancy.

For wind, targeting the RETC levelized cost required the injection of negative adders to the variable O&M costs (called variable O&M benefits, or *vombens*) used by NEMS. These vombens compensate for the differences in levelized costs between RETC and AEO2001. Because NEMS-GPRA includes the vombens directly in the calculation of levelized cost, they function as a straightforward means by which to adjust the levelized cost of energy (COE) used by NEMS-GPRA in its electricity sector production cost and capacity expansion calculations. Specifically, the vombens were calculated (in 1999\$) as the difference between the TC levelized cost and that reported by NEMS-GPRA. The wind vombens were then converted to 1987\$ and were added in the *udat.f* file as a source code manipulation. The use of vombens for wind was required because the *ecpdat* overwrites resulted in a 0.5 ¢/kWh discrepancy by 2020. Through the additional use of vombens, the levelized cost was less than 0.2 ¢/kWh off from the RETC target, resulting in an approximate doubling in wind capacity.

The modifications made to NEMS-GPRA for this simulation, that allow for the implementation of the RETC COE, involved:

- modifying the *ecpdat* input file to:
 - overwrite overnight capital costs and fixed O&M costs for wind, biomass, solar thermal, and solar PV
 - set the project contingency factor ("UPLRPC") = 1.00 for solar thermal and biomass
 - eliminate learning by doing for all renewables
 - extend the wind production tax credit to 2006 as described in Case 1 and adjust the magnitude of the subsidy to account for the pre-tax nature of the credit
 - increase the generation limit of intermittent technologies to 50% from the default 10%
- calculating vombens based on output from the EMMREPT intermediate file (in 1999\$)
- modifying the *udat.f* source file with the vombens for wind (in 1987\$)
- geothermal capital costs and fixed O&M costs were made separately as code changes to renew.f
- modifying the *westech* input file so that wind capacity factors equal RETC assumptions
- modifying the solarin input file so that solar thermal capacity factors match RETC assumptions

Despite the fact that NEMS-GPRA treats the wind resource as three distinct classes, each with its own capacity factor, wind COE is reported in the EMMREPT as having a single levelized cost. This situation makes calculating the levelized cost vombens for wind problematic since the cost

of wind energy varies by wind class. To circumvent the problem, a single COE for wind was calculated as a mix of class 4 and class 6 wind conditions. Under the assumption that the most robust wind resources are most cost competitive and will be developed first, the COE was weighted with an emphasis on class 6 early on, with class 4 representing a greater share of development by 2020. The exact method used to calculate the cost of energy is described in Table 3.

Due to significant changes made to the default coding of the Geothermal Energy Submodule, manipulating the COE through overwrites in the *ecpdat* file or through vombens could not be done. The restructuring of this submodule prevented costs from being overwritten without the loss of information regarding the potential at various sites. Instead, code changes were applied to this case to lower the individual geothermal the various component site costs. This modification is made as a one adjustment to the exploration capital cost by 15%, field capital cost by 15%, and plant capital cost by 25% in the *renew.f* code.

The net effects of overwriting the capital costs and fixed O&M costs as well as the vomben introduction (difference in COE from Case 0) are reported in Table 3. With the exception of the biomass technology, RETC forecasts lower costs of energy than in the reference case.

2.4 Case 4: Combined Heat and Power (HP)

The HP Case 4 incorporates the benefits of additional CHP in industrial as well as commercial sector applications. Capacity additions match those specified by PERI (2001a), as shown in Table 4. The industrial CHP target was 21 GW in 2020 over the 2001 baseline. Approximately 87% (18.2 GW) of this additional industrial CHP was natural gas, with the remaining 13% (2.8 GW) from biomass.

The industrial natural gas CHP additions are introduced using the *icogenwk1* input file. The investment tax credit (ITC) is increased to 15% from the default value of zero, and the capital cost multiplier is reduced from 100% to 75% for years 2001–2010. In addition, the system 3 heat rate was changed from 12,375 Btu/kWh to 13,123 Btu/kWh. The overall efficiency for systems 6 and 7 were increased to 0.78 from 0.74 and 0.72, respectively.

The biomass CHP additions were made via code changes in the *ind.f* module. Resource availability increased by roughly matching the proportions specified by PERI. Each of the four regions is a grouping of the nine census divisions in NEMS-GPRA.

To enhance the commercial CHP, three changes were implemented in this case. The technology capital costs for fuel cells, gas turbines, and micro turbines were reduced gradually to about 10% less than the AEO2001 reference case by 2020. The efficiency improvements were sped up so that the default 2020 improvements are reached ten years earlier, in 2010. The market acceptance parameters were increased from 30% to 50% for maximum potential penetration, and from 60% to 90% for rate of acceptance.

Table 4. CHP Additions Relative to Year 2001, Cases 4 and 7

	2006	2010	2015	2020
HP Case				
Industrial Sector - Natural Gas				
Cumulative Additional Installed CHP Capacity (GW)	6.2	10.7	14.3	18.2
Industrial Sector - Biomass				
Cumulative Additional Installed CHP Capacity (GW)	0.7	1.5	2.1	2.8
Total				
Cumulative Additional Installed CHP Capacity (GW)	6.9	12.2	16.4	21.0

source: National Renewable Energy Laboratory (NREL), fax from Larry Goldstein 4 October 2001

2.5 Case 5: High Natural Gas Price (NG)

The high natural gas price case is achieved by imposing a carbon tax to natural gas in the *PRICE_ADJUST* subroutine of the Emissions Policy Module (*epm.f*). The amount of carbon tax on natural gas use in each sector - residential, commercial, industrial and transportation, as well as in electricity generation are adjusted by applying estimated scalars to the variable *ETAXENDU* and *ETAXELEC*. The adjustment is done on natural gas while petroleum products and coal are left unchanged. The carbon tax is imposed in such a way that the resultant gas price ramps up gradually towards a doubling effect by 2020.

2.6 Case 6: Wind Sensitivity (WN)

Using the 2001 version of NEMS, three different budget scenarios for wind were initially assessed to determine the extent of wind penetration given various levels of research funding that enhance lower wind speed technologies. The three scenarios represent a \$20 million, \$40 million, and \$60 million budgets to the DOE wind program. With the exception of the \$20 million budget, which hinders the advancement of class 4 wind technology, each scenario is modeled to determine the extent to which research programs are able to enhance the class 4 wind technology over time. For the purposes of this report, scenario 2 or the \$40 million budget is the focus for Case 6 as well as for any corresponding AL runs. Brief results are presented for the other two scenarios in the results section.

The baseline for this analysis is a combination TC-FX case. Each of the three budget scenarios is modeled by lowering the forecasted levelized costs and increasing the capacity factors through 2020 in addition to the TC and FX assumptions. In order to represent the enhancement of the low wind speed technology (class 4 wind), the levelized cost over time is lowered to simulate increased penetration of class 4 wind. In 2001, class 6 wind accounts for 100% of the wind resource mix, but by 2010 35% of the mix is class 4 with class 6 taking up the remainder. In 2015, the wind classes are split 50%-50%, and by 2020 70% of wind is class 4 with 30% class 6.

Vombens are added to each scenario as well as to the baseline to more closely match the wind technology targets of each budget and enable comparison with the earlier analysis. Without the

vombens, the baseline amount of additional installed wind capacity is almost half what it would be with the vombens in place. This illustrates the extremely sensitive nature of wind costs on capacity growth.

2.7 Case 7: Scenario Combination (AL)

The AL scenario implements the FX technical fixes, RA green pricing hardwired capacity additions, RETC-projected renewables cost trajectories, the HP industrial and commercial CHP adjustments, the high natural gas price NG case, and the wind sensitivity WN changes exactly as they were implemented for the individual cases described above.

3. Results

For all cases, results are reported in Appendix 1, 2, and 3 for electric generator installed capacity, electric generation and carbon emissions, respectively. These values are given as national totals from 2001 through 2020 for each of the renewable technologies under study, and are compared to the reference case values to show the net impact of the modified assumptions. Table 5 provides a summary of the overall changes in capacity, generation and carbon emissions for each of the scenarios.

Renewable Capacity (GW) Renewable Generation (TWh) **Carbon Emissions (Mt)** Case 1 (FX) 0.5(0.6)1.5 (2.4) 0(1.0)7.2 (3.4) Case 2 (RA) 25.1 (11.6) -4(-3)50.5 (15.9) 199.8 (74.4) -28 (-14) Case 3 (TC) Case 4 (HP) 0.0(0.0)0.0(0.4)-4 (-5) Case 5 (NG) 1.7 (0.3) 4.5 (4.8) -9 (-16) Case 6 (WN) 62.9 (18.7) 261.9 (81.4) -33 (-12)

309.1 (108.3)

-62 (-36)

Table 5. Capacity, Generation, Carbon, and CHP Changes for 2020 (and 2010), Cases 1-7

3.1 FX Case 1

Case 7 (AL)

Appendix Tables 1FX (electric generator capacity), 2FX (electricity generation), and 3FX (carbon emissions) compare the results of Case 1 and Case 0. Technical fixes for wind and intermittent technologies result in a 1.5% increase in electric generation from renewable technologies, corresponding to 1.5 TWh more in 2020. Total installed capacity for the same year increases by 0.5 GW or 2.9%.

This effect is almost entirely due to the extension of the wind production tax credit by five years to 2006. As well, an adjustment is made to the magnitude of this subsidy to correct for the fact that the credit is a deduction from tax-owed (after-tax). Thus, the subsidy before tax is the credit/(1-tax rate). Solar thermal and PV show no effect from the changes implemented. This is because the levelized costs of solar energy are too high throughout the forecast period (above 10 ¢/kWh) for it to be competitive.

Not surprisingly, the net carbon emissions effect of the FX case is minimal.

76.2 (24.5)

3.2 RA Case 2

Appendix Tables 1RA, 2RA, and 3RA show the equivalent tables for the RA Case 2. Forced capacity additions are implemented into NEMS-GPRA as shown in Table 2. In this scenario, all

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renewables benefit in the majority of years from the forced additions. The increase is fairly steady, starting in 2002 and ramping over the forecast period.

Overall, this case resulted in a 26% increase in renewable electric generation in 2020, up from 97.8 TWh to 122.8 TWh. Approximately 51% of this increase in 2020 is from wind, contributing an additional 12.7 TWh, with roughly 22% from geothermal, a 5.5 TWh increase from 25.8 TWh. For biomass, the 0.6 GW of forced builds is estimated to result in a 1.3 TWh increase by 2020. Because biomass is reported as a sum from both dedicated plants and cofiring, this amount is masked in the output tables by fluctuations in the biomass cofiring. Solar thermal generation increases by roughly 10% of the total renewable generation increase, a 2.4 TWh increase from 1.4 TWh. Installed generating capacity increases 7.2 GW by 2020 for all renewable technologies, with 63% of this increase from wind additions. For all technologies except PV, generation increases proportionally more than capacity, reflecting improving technology.

In the RA Case 2, annual carbon savings reach 4.0 Mt by 2020, a 0.2% reduction from total U.S. carbon emissions.

3.3 TC Case 3

The TC Case 3 can be interpreted as the competitive outcome if renewables cost trajectories are close to those reported in the RETC, while all other AEO2001 assumptions are left unchanged.

Appendix Tables 1TC, 2TC, and 3TC represent the results from adjusting the levelized costs of each technology to reflect the RETC forecast. Overall, electric generation from renewables increases by 204% in 2020 with 1325% and 105% increases in wind and geothermal generation, respectively. Notably, wind power experiences the most significant boost from the RETC cost projections. Wind generation increases by 174 TWh from just over 13 TWh in 2020. The increase in capacity over the reference case starts early, when the cost of energy reaches around 3¢/kWh. Wind also shows the greatest capacity effect, resulting in over 47 GW more capacity in 2020, a 816% increase. Based on these capacity and generation results, it can be determined that the capacity factor of wind generation increases from about 26% to 42%. Geothermal increases its installed generating capacity by 78% in 2020 relative to the reference case, up from 4.41 GW to 7.85 GW in the final forecast year.

In contrast, despite a dramatic reduction in the levelized cost of energy, PV and solar thermal show no change as a result of lowering its costs of energy. With PV and solar thermal costs forecasted by 2020 to be 9.1 $\ensuremath{\varepsilon}$ /kWh and 7.9 $\ensuremath{\varepsilon}$ /kWh, respectively, the cost of these technologies are likely still too high to compete with other technologies at the wholesale level.

With biomass, installed capacity does not change throughout the forecast period. Biomass cost of energy also remains relatively high, starting at 5.8 ¢/kWh and never dropping below 5.3 ¢/kWh.

The TC Case 3 scenario includes a significant reduction in carbon emissions as a result of enhanced renewables use. By 2020, electricity sector emissions are reduced by 28 Mt/a, which translates to a reduction of 1.4% of total U.S. carbon emissions.

3.4 HP Case 4

Appendix Tables 1HP, 2HP, and 3HP present the results from the HP Case 4 run of increasing the industrial natural gas and biomass CHP as well as some changes to commercial natural gas CHP. With a total increase of 21 GW by 2020 relative to the 2001 baseline, carbon emissions are reduced 4 Mt in the final forecast year. A significant share of the 7.4 Mt of carbon saved in the power sector is offset by an increase of 2.6 Mt in the industrial sector due to gas use on-site. Net carbon emissions savings are still realized in this case due to the increased biomass CHP usage. Renewable capacity or generation is not affected throughout the forecast period. Appendix Table 4 illustrates how the increased fuel consumption from industrial natural gas CHP outweighs the reduction from electric generation.

3.5 NG Case 5

Appendix Tables 1NG, 2NG, and 3NG show the NG case results. Simulation of a doubled natural gas fuel price in the residential, commercial, industrial, transportation, and electricity sectors by 2020 resulted in an overall carbon reduction of 9 Mt by 2020. The appearance of a large (45.5 Mt in 2020) carbon savings from doubled natural gas prices is largely offset by increased electricity sector emissions from fuel switching from natural gas to coal. As a result of high natural gas prices, renewables capacity increases by a total of 1.7 GW in 2020, with 0.5 GW from geothermal, 0.4 GW from MSW and biomass capacity increasing by 0.7 GW.

below summarizes the resulting natural gas prices by sector from imposing a carbon tax on natural gas use. In general, the prices were approximately doubled in 2020, about 60-65% above AEO2001 prices in 2015 and approximately 35% above in 2010.

1999\$/MBtu	2000	2005	2010	2015	2020
Residential	7.19	6.63	8.68	10.52	12.35
Commercial	5.70	5.31	7.37	9.00	10.64
Industrial	4.00	3.17	4.46	5.50	6.48
Transportation	7.94	6.80	9.49	11.75	13.87

Table 6. Natural Gas Prices by Sector (1999\$/Mbtu)

3.6 WN Case 6

Table 7 summarizes the results from runs experimenting with three wind budget scenarios that favor various levels of low wind speed class 4 enhancement. A combination of Cases 1 and 3, TC-FX, serve as the baseline. The TC-FX run results in 12.5 GW more wind in 2010 and 47.2 GW by 2020. Under scenario 1, the cost of wind energy in 2020 is actually higher than the baseline, 3.38 ¢/kWh in 2020 relative to RETC's 3.02 ¢/kWh. However, with the lowered CF relative to the baseline it is difficult to make any direct conclusions about the results. The wind capacity increases under this case are about the same as the baseline, with 45.9 GW more wind in 2020 1.3 GW less than the TC-FX baseline in this last forecast year. Scenario 2 represents a 2.50 ¢/kWh wind cost in 2020 about 0.5 ¢/kWh lower than the baseline, which results in nearly 13 GW more wind capacity by 2020 compared to the TC-FX baseline. Under this \$40 million

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budget scenario, an additional 5 Mt of carbon emissions are reduced under this scenario by 2020 as a result of this reduced wind cost projection over the TC-FX baseline. Scenario 3 represents the \$60 million wind program budget in which the class 4 technology is able to make the greatest advances, lowering the cost of the wind mix to 2.4 ¢/kWh by 2020. This results in 24.6 GW more wind capacity over the TC-FX baseline and a nearly 70% increase in wind generation with carbon emissions reductions 10 Mt more than the baseline in 2020.

Table 7. Summary of Case 6 Wind Budget Scenario Results

Year 2020 Results	GPRA01 TCFX baseline	Scenario 1 (\$20 million)	Scenario 2 (\$40 million)	Scenario 3 (\$60 million)
COE (c/kWh)	3.02	3.38	2.50	2.37
CF Class 4	0.38	0.32	0.45	0.46
LBL COE (c/kWh)	3.05	3.42	2.43	2.49
Capacity (GW)	47.2	45.9	59.9	71.8
Generation (TWh)	173.6	168.4	238.1	292.7
Carbon Emissions (Mt)	-28.0	-24.0	-33.0	-38.0

Tables 1WN, 2WN, and 3WN show the WN case results for wind scenario 2. Any AL runs involving WN include the results from analyzing the \$40 million budget scenario, which is seen as the most widely accepted budget of the three.

3.7 AL Case 7

The effects of the combined modifications to NEMS-GPRA are shown in Appendix Tables 1AL, 2AL and 3AL. Figure 3 compares the total capacity of each renewable technology in 2020 for each of the six simulations and the reference case. As this figure illustrates, the combined effects of all assumptions are larger than any applied separately, yet less than their sum. Clearly, wind is highly sensitive to the imposed changes, especially through lowered cost of energy. Geothermal also exhibits some response to lowered site costs with biomass, solar thermal, and solar PV showing very little stimulus to the proposed changes. A comparison of total renewable capacity additions under each scenario is presented by year in Figure 4.

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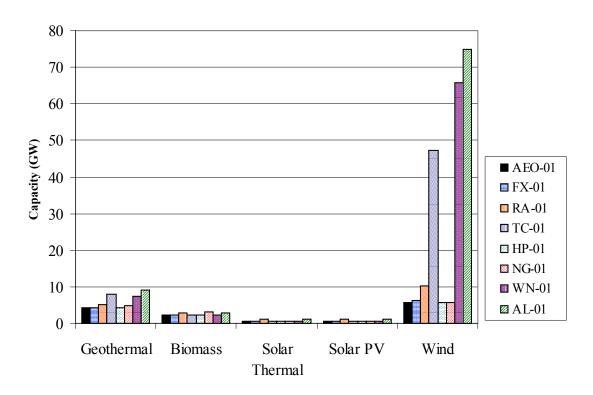


Figure 3. Total Non-Hydro Renewable Capacity in 2020 by Technology

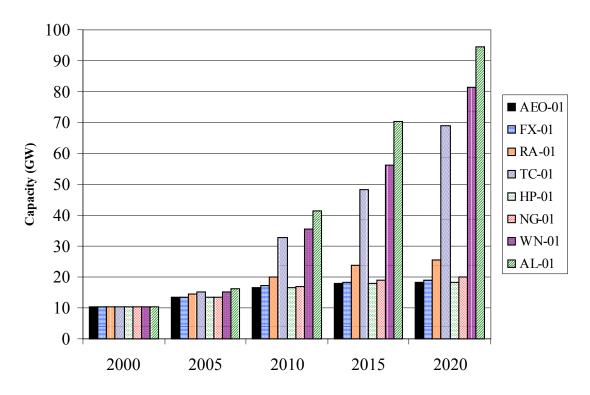


Figure 4. Total Non-Hydro Renewable Energy Capacity

As in the AL Case 7, wind benefits most from the assumptions in place for the scenario and is up even from the WN Case 6. Wind generation increases over 21 times that of the reference case by 2020 in AL Case 7. Solar thermal and PV also show increases, with generation in 2020 up nearly 2.8 times and 1.9 times, respectively. Generation from geothermal more than doubles during the forecast period. Biomass shows a significant decrease in generation over the reference case, due to the presence of biomass cofiring in the reported results.

As expected from the above results, AL also reports the greatest carbon savings. Total emissions are reduced by 62 Mt/a by 2020, which is 8% of the electricity sector or 3% of total energy-related emissions.

4. Conclusions

FX Case 1 technical fixes, RA Case 2 forced capacity additions, TC Case 3 levelized cost modifications, HP Case 4 CHP adjustments, NG Case 5 high natural gas prices, WN Case 6 wind cost sensitivity, and the AL Case 7 combined scenarios were implemented into NEMS-GPRA. The scenarios were designed to simulate the potential benefits to renewable energy technologies of (1) a more competitive marketplace that includes direct access for customers and green marketing-induced capacity additions, (2) more aggressive advances in the factors that drive the cost of renewable energy and (3) more rapid penetration of industrial and commercial CHP, than forecast by the AEO2001 Reference Case.

These runs comprehensively incorporate the forced renewable CHP capacity additions as specified by PERI (2001a) and, with the exception of MSW, the renewables levelized cost of energy forecasts reported in the 1997 Renewable Energy Technology Characterizations (RETC) for six renewable energy technologies through 2020. Modifications to improve the treatment of certain renewable energy technologies by the model were also implemented. Results indicate a substantial increase in renewable electric power generation as well as a significant reduction in carbon emissions for each of the scenarios. Generally, the AL case produced the most dramatic results, although individual technologies were affected differently in each case. Wind development received the greatest boost from the modifications to NEMS-GPRA. For all technologies, the AL case resulted in an increase in generation that was greater than either the increase in the individual simulations, but less than their sum.

Wind, which has a comparatively low cost of energy in the RETC, experienced an increase in generation in the AL case over nearly 21 times that of the reference case by 2020.

Solar thermal generation was up 2.8 times and geothermal up 2.5 times over the reference by 2020 in the AL Case 7.

The forecast for PV, with its relatively high cost of energy, did not change in the TC Case 3 case, but generation did increase by 93% in 2020 in both the RA Case 2 and AL Case 7.

The projection for MSW, a 13.3% increase in generation by 2020, is the same for AL and RA Case 2, as expected since cost of energy assumptions have not changed from the reference case.

In each scenario, carbon emissions decreased in comparison to AEO2001 every year between 2001 and 2020. By 2020, carbon emissions were down 4 Mt/a (0.2%) in RA Case 2, 28 Mt/a (1.4%) in TC Case 3, 4 Mt/a (0.2%) in HP Case 4, 9 Mt/a (0.4% in NG Case 5, 33 Mt/a (1.6%) in WN Case 6, and 62 Mt/a (3%) in AL Case 7.

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Appendix of Tables

Table FX-1. Case 1 Capacity from Renewable Technologies and AEO2001

Appendix 1FX. Electric Gen	χ 1FX.	. Elec	tric (erators' Capacity of Renewable Technologies ¹ (GW):	's' Ca	ıpacit	y of	Rene	wabl	le Te	chnol	logies	3 ₁ (G		Case	Case 1 and AEO2001	AE	0200	1^2	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 FX01 Difference % Difference	2.93 2.93 0.0 0.0	2.93 2.93 0.0	2.93 2.93 0.0	2.93 2.93 0.0 0.0	2.88 2.88 0.0 0.0	3.15 3.15 0.0 0.0	3.34 3.34 0.0 0.0	3.79 3.79 0.0 0.0	4.05 4.04 0.0 -0.2	4.21 4.20 0.0 -0.2	4.34 4.34 0.0 0.0	4.41 4.40 0.0 -0.2	4.41 4.40 0.0 -0.2	4.41 4.40 0.0 -0.2	4.41 4.40 0.0 -0.2	4.41 4.40 0.0 -0.2	4.41 4.40 0.0	4.40 0.0 -0.2	4.40 0.0 -0.2	4.41 4.40 0.0 -0.2	4.41 4.40 0.0 -0.2
Municipal Solid Waste	olid Was	te																			
AEO2001 FX01 Difference % Difference	2.64 2.64 0.0 0.0	2.76 2.76 0.0 0.0	2.78 2.78 0.0 0.0	2.81 2.81 0.0 0.0	3.54 3.54 0.0 0.0	3.80 3.80 0.0 0.0	3.84 3.84 0.0 0.0	3.90 3.90 0.0 0.0	3.98 3.98 0.0 0.0	4.08 4.08 0.0 0.0	4.20 4.20 0.0 0.0	4.34 4.34 0.0 0.0	4.51 4.51 0.0 0.0	4.53 4.53 0.0 0.0	4.55 4.55 0.0 0.0	4.57 4.57 0.0 0.0	4.64 4.64 0.0 0.0	4.66 4.66 0.0 0.0	4.68 4.68 0.0 0.0	4.70 4.70 0.0 0.0	4.72 4.72 0.0 0.0
Biomass																					
AEO2001 FX01 Difference % Difference	1.53 1.53 0.0 0.0	1.54 1.54 0.0 0.0	1.60 1.60 0.0 0.0	1.62 1.62 0.0 0.0	1.66 1.66 0.0 0.0	1.68 1.68 0.0 0.0	1.71 1.71 0.0 0.0	1.76 1.76 0.0 0.0	1.84 1.84 0.0 0.0	1.93 1.93 0.0	2.04 2.04 0.0 0.0	2.17 2.17 0.0 0.0	2.32 2.32 0.0 0.0	2.32 2.32 0.0 0.0	2.32 2.32 0.0 0.0	2.33 2.33 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0
Solar Therma	귾																				
AEO2001 FX01 Difference % Difference	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.34 0.34 0.0 0.0	0.35 0.35 0.0 0.0	0.35 0.35 0.0 0.0	0.36 0.36 0.0 0.0	0.37 0.37 0.0	0.38 0.38 0.0 0.0	0.39 0.39 0.0 0.0	0.40 0.40 0.0 0.0	0.40 0.40 0.0 0.0	0.41 0.0 0.0	0.42 0.42 0.0 0.0	0.43 0.0 0.0	0.44 0.44 0.0	0.44 0.0 0.0	0.45 0.0 0.0	0.46 0.46 0.0 0.0	0.47 0.47 0.0	0.48 0.48 0.0
Solar Photovoltaic	oltaic																				
AEO2001 FX01 Difference % Difference	0.01 0.01 0.0	0.02 0.02 0.0 0.0	0.03 0.03 0.0	0.05 0.05 0.0	0.06 0.06 0.0	0.09 0.09 0.0	0.11 0.11 0.0	0.13 0.13 0.0 0.0	0.15 0.15 0.0 0.0	0.18 0.18 0.0 0.0	0.21 0.21 0.0 0.0	0.24 0.24 0.0 0.0	0.27 0.27 0.0 0.0	0.30 0.30 0.0	0.33 0.33 0.0 0.0	0.37 0.37 0.0 0.0	0.40 0.40 0.0 0.0	0.44 0.0 0.0	0.47 0.47 0.0 0.0	0.51 0.51 0.0 0.0	0.54 0.54 0.0 0.0
Wind																					
AEO2001 FX01 Difference % Difference	2.76 2.76 0.0 0.0	3.53 3.53 0.0 0.0	3.80 3.80 0.0 0.0	4.01 4.01 0.0 0.0	4.22 4.28 0.1 1.4	4.43 4.49 0.1 1.4	4.65 5.22 0.6 12.3	4.89 5.46 0.6 11.7	5.14 5.71 0.6 11.1	5.41 5.98 0.6 10.5	5.51 6.08 0.6 10.3	5.58 6.15 0.6 10.2	5.67 6.24 0.6 10.1	5.67 6.24 0.6 10.1	5.67 6.24 0.6 10.1	5.70 6.27 0.6 10.0	5.73 6.30 0.6 9.9	5.73 6.30 0.6 9.9	5.73 6.30 0.6 9.9	5.76 6.30 0.5 9.4	5.78 6.32 0.5 9.3
TOTALS																					
AEO2001 FX01 Difference % Difference	10.20 10.20 0.0 0.0	11.11 11.11 0.0 0.0	11.47 11.47 0.0 0.0	11.76 11.76 0.0 0.0	12.71 12.77 0.1 0.5	13.50 13.56 0.1 0.4	14.01 14.58 0.6 4.1	14.84 15.41 0.6 3.8	15.54 16.10 0.6 3.6	16.20 16.76 0.6 3.5	16.70 17.27 0.6 3.4	17.14 17.70 0.6 3.3	17.59 18.15 0.6 3.2	17.65 18.21 0.6 3.2	17.71 18.27 0.6 3.2	17.82 18.38 0.6 3.1	17.99 18.55 0.6 3.1	18.06 18.62 0.6 3.1	18.12 18.68 0.6 3.1	18.22 18.75 0.5 2.9	18.30 18.83 0.5 2.9
¹ Excludes cogeneration ² From AEO2001 Table A17 ³ Includes landfill gas	eneratio 001 Tabl fill gas	n e A17																			

Table FX- 2. Case 1 Generation from Renewable Technologies and AEO2001

Appendix 2FX. Electric Genera	2FX.	Elect	ric G	ener		, Gei	nerati	ion fr	om R	enew	tors' Generation from Renewable Technologies ¹	Fech	iologi		(TWh):): Ca	se 1 8	and A	Case 1 and AEO2001 ²	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 FX01 Difference % Difference	13.39 13.39 0.0 0.0	13.56 13.56 0.0 0.0	13.59 13.59 0.0 0.0	13.60 13.60 0.0 0.0	13.56 13.56 0.0 0.0	15.86 15.85 0.0 -0.1	17.36 17.36 0.0 0.0	20.89 20.88 0.0 0.0	22.92 22.86 -0.1	24.17 24.14 0.0 -0.1	25.27 25.25 0.0 -0.1	25.77 25.71 -0.1	25.78 25.72 -0.1	25.78 25.72 -0.1	25.80 25.74 -0.1 -0.2	25.81 25.75 -0.1	25.81 25.75 -0.1	25.81 25.76 0.0 -0.2	25.82 25.76 -0.1	25.82 25.77 -0.1	25.83 25.77 -0.1 -0.2
Municipal Solid Waste ³ AEO2001 18.36 FX01 18.36 Difference 0.0 % Difference 0.0	d Waste 18.36 18.36 0.0	19.03 19.03 0.0 0.0	19.44 19.44 0.0 0.0	19.64 19.64 0.0 0.0	25.36 25.36 0.0 0.0	27.35 27.35 0.0 0.0	27.63 27.63 0.0 0.0	28.01 28.01 0.0 0.0	28.53 28.53 0.0 0.0	29.19 29.19 0.0 0.0	30.00 30.00 0.0 0.0	30.96 30.95 0.0 0.0	32.08 32.07 0.0 0.0	32.59 32.59 0.0 0.0	32.74 32.74 0.0 0.0	32.88 32.88 0.0 0.0	33.26 33.26 0.0 0.0	33.51 33.51 0.0 0.0	33.65 33.65 0.0 0.0	33.81 33.81 0.0 0.0	33.96 33.96 0.0 0.0
Biomass AEO2001 FX01 Difference % Difference	10.77 10.77 0.0 0.0	13.62 13.58 0.0 -0.3	17.06 16.82 -0.2 -1.4	14.27 14.29 0.0 0.1	15.07 15.16 0.1 0.6	17.27 17.94 0.7 3.9	19.41 19.07 -0.3 -1.8	19.77 19.58 -0.2 -1.0	20.51 20.48 0.0 -0.1	20.57 21.36 0.8 3.8	21.59 22.38 0.8 3.7	21.66 21.96 0.3 1.4	21.71 22.76 1.1 4.8	22.52 22.96 0.4 2.0	22.65 22.84 0.2 0.8	23.21 23.31 0.1 0.4	23.25 23.27 0.0 0.1	23.10 24.33 1.2 5.3	22.64 22.65 0.0 0.0	22.47 22.44 0.0 -0.1	22.15 22.12 0.0 -0.1
Solar Thermal AEO2001 FX01 Difference % Difference	0.89 0.0 0.0	0.89 0.0 0.0	0.90 0.90 0.0 0.0	0.91 0.0 0.0 0.0	0.94 0.94 0.0	0.96 0.96 0.0	0.98 0.98 0.0	1.01 1.01 0.0 0.0	1.05 1.05 0.0 0.0	1.08 0.0 0.0	11.11 0.0	1.13 1.13 0.0 0.0	1.15 1.15 0.0 0.0	1.17 1.17 0.0 0.0	1.2.1 1.2.1 0.0 0.0	1.24 1.24 0.0 0.0	1.26 1.26 0.0 0.0	1.29 1.29 0.0 0.0	1.31 1.31 0.0 0.0	1.34 1.34 0.0 0.0	1.37 1.37 0.0 0.0
Solar Photovoltaic AEO2001 FX01 Difference % Difference	taic 0.04 0.04 0.0 0.0	0.05 0.05 0.0	0.07 0.07 0.0 0.0	0.11 0.0 0.0	0.15 0.0 0.0 0.0	0.20 0.20 0.0 0.0	0.26 0.26 0.0 0.0	0.31 0.31 0.0 0.0	0.37 0.37 0.0 0.0	0.44 0.0 0.0	0.51 0.51 0.0 0.0	0.59 0.59 0.0 0.0	99.0 9.0 0.0 0.0	0.74 0.74 0.0 0.0	0.83 0.83 0.0 0.0	0.92 0.92 0.0 0.0	1.01	1.10 0.0 0.0	1.18 1.18 0.0 0.0	1.27 1.27 0.0 0.0	1.36 1.36 0.0 0.0
Wind AEO2001 FX01 Difference % Difference	5.18 5.18 0.0 0.0	6.62 6.62 0.0 0.0	7.73 7.73 0.0 0.0	8.33 8.33 0.0 0.0	8.88 9.05 0.2 1.9	9.42 9.60 0.2 1.9	10.00 11.62 1.6 1.6	10.62 12.24 1.6 1.6	11.26 12.88 1.6 14.4	11.94 13.55 1.6 13.5	12.33 13.95 1.6 1.6	12.52 14.14 1.6 1.6	12.71 14.33 1.6 12.7	12.78 14.39 1.6 12.6	12.78 14.39 1.6 12.6	12.84 14.46 1.6 12.6	12.91 14.53 1.6 12.5	12.93 14.55 1.6 12.5	12.94 14.55 1.6 12.4	13.02 14.55 1.5 11.8	13.10 14.64 1.5 12
TOTALS AEO2001 FX01 Difference % Difference	48.63 48.63 0.0 0.0	53.77 53.73 0.0 -0.1	58.79 -0.2 -0.4	56.86 56.88 0.0 0.0	63.96 64.22 0.3 0.4	71.06 71.90 0.8 1.2	75.64 76.92 1.3 1.7	80.61 82.03 1.4 1.8	84.64 86.17 1.5 1.8	87.39 89.76 2.4 2.7	90.81 93.20 2.4 2.6	92.63 94.5 1.9 2.0	94.09 96.7 2.6 2.8	95.58 97.6 2.0 2.1	96.01 97.8 1.7 1.8	96.90 98.6 1.7 1.7	97.50 99.1 1.6 1.6	97.74 100.5 2.8 2.9	97.54 99.1 1.6 1.6	97.73 99.2 1.5 1.5	97.77 99.2 1.5 1.5
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table 11 gas	A17																			

Table FX-3. Case 1 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3FX. Total Carbon E	3FX.	Fotal	Carb		missi	ons (Mt/a)): Ca	se 1 8	and A	missions (Mt/a): Case 1 and AEO2001	001^{1}									
,	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum AEO2001 FX01 Difference % Difference	631.2 631.2 0.0 0.0	648.0 648.0 0.0 0.0	661.7 661.7 0.0 0.0	672.4 672.4 0.0 0.0	683.5 683.5 0.0 0.0	695.5 695.5 0.0 0.0	707.6 707.6 0.0 0.0	719.5 719.4 -0.1 0.0	730.3 730.3 0.0 0.0	740.5 740.5 0.0 0.0	750.6 750.6 0.0 0.0	760.3 760.3 0.0 0.0	769.5 769.3 -0.2 0.0	780.8 780.8 0.0 0.0	792.4 792.3 -0.1 0.0	803.7 803.6 -0.1 0.0	815.0 815.0 0.0 0.0	825.4 825.4 0.0 0.0	835.4 835.4 0.0 0.0	845.5 845.5 0.0 0.0	856.1 856.1 0.0 0.0
Natural Gas AEO2001 FX01 Difference % Difference	265.4 265.4 0.0 0.0	272.1 272.1 0.0 0.0	279.4 279.4 0.0 0.0	285.3 285.3 0.0 0.0	289.2 289.2 0.0 0.0	291.9 291.9 0.0 0.0	296.2 296.1 -0.1 0.0	299.7 299.7 0.0 0.0	303.1 303.2 0.1 0.0	306.1 306.1 0.0 0.0	309.8 309.8 0.0 0.0	312.9 312.9 0.0 0.0	316.6 316.9 0.3 0.1	319.9 319.9 0.0 0.0	323.4 323.4 0.0 0.0	327.5 327.4 -0.1 0.0	331.0 330.8 -0.2 -0.1	334.1 334.0 -0.1 0.0	337.2 337.1 -0.1 0.0	340.0 340.0 0.0 0.0	343.3 343.2 -0.1 0.0
Coal AEO2001 FX01 Difference % Difference	68.9 0.0 0.0	69.0 0.0 0.0	68.7 68.7 0.0 0.0	69.4 69.4 0.0 0.0	69.4 69.4 0.0 0.0	69.6 69.6 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.4 -0.1	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.6 69.6 0.0 0.0
Other AEO2001 FX01 Difference % Difference	0.0	0.0	0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.0	0.0	0.0 0.0 0.0	0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.0	0.1 0.0 0.0
Electricity AEO2001 FX01 Difference % Difference	569.8 569.8 0.0 0.0	587.4 587.3 -0.1 0.0	601.6 601.5 -0.1 0.0	615.6 615.5 -0.1 0.0	625.4 625.3 -0.1 0.0	633.1 632.9 -0.2 0.0	639.6 638.5 -1.1	653.2 653.0 -0.2 0.0	661.6 661.6 0.0 0.0	667.8 667.9 0.1 0.0	679.1 679.9 0.8 0.1	687.1 687.1 0.0 0.0	695.7 694.8 -0.9	706.3 705.6 -0.7 -0.1	715.5 715.0 -0.5 -0.1	727.5 728.1 0.6 0.1	735.1 736.6 1.5 0.2	746.5 745.9 -0.6	753.7 753.7 0.0 0.0	761.5 761.2 -0.3 0.0	771.5 771.6 0.1 0.0
AEO2001 1535 115 155 15 15 15 15 15 15 15 15 15 15	1535 1535 0.0 0.0	1577 1576 -1.0 -0.1	1611 1611 0.0 0.0	1643 1643 0.0 0.0	1668 1668 0.0 0.0	1690 1690 0.0 0.0	1713 1712 -1.0 -0.1	1742 1742 0.0 0.0	1765 1765 0.0 0.0	1784 1784 0.0 0.0	1809 1810 1.0 0.1	1830 1830 0.0 0.0	1851 1851 0.0 0.0	1877 1876 -1.0	1901 1900 -1.0 -0.1	1928 1929 1.0 0.1	1951 1952 1.0 0.1	1976 1975 -1.0	1996 1996 0.0 0.0	2017 2016 -1.0 0.0	2041 2041 0.0 0.0

Table RA-1. Case 2 Capacity from Renewable Technologies and AEO2001

Appendix 1RA. Electric Gener	1RA	. Elec	tric (Gene	•	s, Ca	ıpaci	ty of	Rene	wab]	le Te	chno]	ators' Capacity of Renewable Technologies ¹ (GW):	31 (G	W):	Case	Case 2 and AEO2001 ²	d AE	0200	1^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 RA01 Difference % Difference	2.93 2.93 0.0 0.0	2.93 2.93 0.0 0.0	2.93 2.93 0.0 0.0	2.93 2.96 0.0 1.0	2.88 2.92 0.0 1.4	3.15 3.22 0.1 2.2	3.34 3.43 0.1 2.7	3.79 3.90 0.1 2.9	4.05 4.21 0.2 4.0	4.21 4.39 0.2 4.3	4.34 4.58 0.2 5.5	4.41 4.70 0.3 6.6	4.41 4.75 0.3 7.7	4.41 4.80 0.4 8.8	4.41 4.85 0.4 10.0	4.41 4.90 0.5 11.11	4.41 4.94 0.5 12.0	4.41 4.97 0.6 12.7	4.41 5.01 0.6 13.6	4.41 5.05 0.6 14.5	4.41 5.08 0.7 15.2
Municipal Solid Waste	lid Was	te																			
AEO2001 RA01 Difference % Difference	2.64 2.64 0.0 0.0	2.76 2.76 0.0 0.0	2.78 2.78 0.0 0.0	2.81 2.83 0.0 0.7	3.54 3.50 0.0 -1.1	3.80 3.84 0.0 1.1	3.84 3.89 0.1 1.3	3.90 3.97 0.1 1.8	3.98 4.07 0.1 2.3	4.08 4.19 0.1 2.7	4.20 4.34 0.1 3.3	4.34 4.49 0.2 3.5	4.51 4.67 0.2 3.5	4.53 4.71 0.2 4.0	4.55 4.74 0.2 4.2	4.57 4.78 0.2 4.6	4.64 4.86 0.2 4.7	4.66 4.89 0.2 4.9	4.68 4.92 0.2 5.1	4.70 4.96 0.3 5.5	4.72 4.99 0.3 5.7
Biomass																					
AEO2001 RA01 Difference % Difference	1.53 1.53 0.0 0.0	1.54 1.54 0.0 0.0	1.60 1.60 0.0 0.0	1.62 1.65 0.0 1.9	1.66 1.71 0.1 3.0	1.68 1.75 0.1 4.2	1.71 1.81 0.1 5.8	1.76 1.89 0.1 7.4	1.84 2.00 0.2 8.7	1.93 2.14 0.2 10.9	2.04 2.29 0.3 12.3	2.17 2.46 0.3 13.4	2.32 2.64 0.3 13.8	2.32 2.68 0.4 15.5	2.32 2.72 0.4 17.2	2.33 2.77 0.4 18.9	2.37 2.84 0.5 19.8	2.37 2.86 0.5 20.7	2.37 2.88 0.5 21.5	2.37 2.90 0.5 22.4	2.37 2.92 0.6 23.2
Solar Therma	-																				
AEO2001 RA01 Difference % Difference	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.34 0.34 0.0	0.35 0.36 0.0 2.9	0.35 0.37 0.0 5.7	0.36 0.38 0.0 5.6	0.37 0.40 0.0 8.1	0.38 0.46 0.1 21.1	0.39 0.52 0.1 33.3	0.40 0.58 0.2 45.0	0.40 0.63 0.2 57.5	0.41 0.69 0.3 68.3	0.42 0.74 0.3 76.2	0.43 0.80 0.4 86.0	0.44 0.86 0.4 95.5	0.44 0.89 0.5 102.3	0.45 0.92 0.5 104.4	0.46 0.96 0.5 108.7	0.47 0.99 0.5 110.6	0.48 1.03 0.6 114.6
Solar Photovoltaic	oltaic																				
AEO2001 RA01 Difference % Difference	0.01 0.01 0.0	0.02 0.02 0.0 0.0	0.03 0.03 0.0 0.0	0.05 0.05 0.0	0.06 0.07 0.0 16.7	0.09 0.09 0.0	0.11 0.12 0.0 9.1	0.13 0.14 0.0 7.7	0.15 0.21 0.1 40.0	0.18 0.28 0.1 55.6	0.21 0.35 0.1 66.7	0.24 0.44 0.2 83.3	0.27 0.52 0.3 92.6	0.30 0.61 0.3 103.3	0.33 0.70 0.4 112.1	0.37 0.79 0.4 113.5	0.40 0.87 0.5 117.5	0.44 0.96 0.5 118.2	0.47 1.04 0.6 121.3	0.51 1.12 0.6 119.6	0.54 1.20 0.7 122.2
Wind																					
AEO2001 RA01 Difference % Difference	2.76 2.76 0.0 0.0	3.53 3.53 0.0 0.0	3.80 3.80 0.0 0.0	4.01 4.28 0.3 6.7	4.22 4.75 0.5 12.6	4.43 5.22 0.8 17.8	4.65 5.71 1.1 22.8	4.89 6.21 1.3 27.0	5.14 6.83 1.7 32.9	5.41 7.46 2.1 37.9	5.51 7.93 2.4 43.9	5.58 8.31 2.7 48.9	5.67 8.71 3.0 53.6	5.67 9.02 3.4 59.1	5.67 9.33 3.7 64.6	5.70 9.67 4.0 69.6	5.73 9.80 4.1 71.0	5.73 9.90 4.2 72.8	5.73 10.00 4.3 74.5	5.76 10.12 4.4 75.7	5.78 10.24 4.5 77.2
TOTALS																					
AEO2001 RA01 Difference % Difference	10.20 10.20 0.0 0.0	11.11 11.11 0.0 0.0	11.47 11.47 0.0	11.76 12.11 0.4 3.0	12.71 13.31 0.6 4.7	13.50 14.49 1.0 7.3	14.01 15.34 1.3 9.5	14.84 16.51 1.7 11.3	15.54 17.78 2.2 14.4	16.20 18.98 2.8 17.2	16.70 20.07 3.4 20.2	17.14 21.03 3.9 22.7	17.59 21.98 4.4 25.0	17.65 22.56 4.9 27.8	17.71 23.14 5.4 30.7	17.82 23.77 6.0 33.4	17.99 24.20 6.2 34.5	18.06 24.50 6.4 35.7	18.12 24.81 6.7 36.9	18.22 25.14 6.9 38.0	18.30 25.46 7.2 39.1
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	eneratio 01 Tabl ill gas	n e A17																			

²⁹

Table RA- 2. Case 2 Generation from Renewable Technologies and AEO2001

Appendix 2RA.	2RA.	Elec	tric (rener	ator	s' Ge	nerat	ion fi	Electric Generators' Generation from Renewable Technologies ¹	kenew	'able	Tech	nolog		(TWh):		ase 2	and ∤	Case 2 and AEO2001 ²	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 RA01 Difference	13.39 13.39 0.0 0.0	13.56 13.56 0.0 0.0	13.59 13.59 0.0 0.0	13.60 13.79 0.2 1.4	13.56 13.94 0.4 2.8	15.86 16.41 0.6 3.5	17.36 18.10 0.7 4.3	20.89 21.81 0.9 4.4	22.92 24.24 1.3 5.8	24.17 25.70 1.5 6.3	25.27 27.22 2.0 2.0	25.77 28.14 2.4 9.2	25.78 28.56 2.8 10.8	25.78 28.98 3.2 12.4	25.80 29.41 3.6 14.0	25.81 29.83 4.0 15.6	25.81 30.13 4.3 16.7	25.81 30.43 4.6 17.9	25.82 30.73 4.9 19.0	25.82 31.02 5.2 20.1	25.83 31.32 5.5 21.3
Municipal Solid Waste AEO2001 18.36 RA01 18.36 Difference 0.0 % Difference 0.0	id Waste 18.36 18.36 0.0 0.0	19.03 19.03 0.0 0.0	19.44 19.44 0.0 0.0	19.64 19.74 0.1 0.5	25.36 25.00 -0.4 -1.4	27.35 27.64 0.3 1.1	27.63 28.01 0.4 1.4	28.01 28.49 0.5 1.7	28.53 29.17 0.6 2.2	29.19 29.99 0.8 2.7	30.00 30.96 1.0 3.2	30.96 32.02 1.1 3.4	32.08 33.24 1.2 3.6	32.59 33.85 1.3 3.9	32.74 34.10 1.4 4.2	32.88 34.34 1.5 4.4	33.26 34.80 1.5 4.6	33.51 35.14 1.6 4.9	33.65 35.37 1.7 5.1	33.81 35.62 1.8 5.4	33.96 35.86 1.9 5.6
Biomass AEO2001 RA01 Difference % Difference	10.77 10.34 -0.4 -4.0	13.62 15.66 2.0 15.0	17.06 16.86 -0.2 -1.2	14.27 13.97 -0.3	15.07 15.04 0.0 -0.2	17.27 18.80 1.5 8.9	19.41 19.07 -0.3 -1.8	19.77 19.83 0.1 0.3	20.51 22.04 1.5 7.5	20.57 21.94 1.4 6.7	21.59 22.29 0.7 3.2	21.66 22.92 1.3 5.8	21.71 23.48 1.8 8.2	22.52 23.69 11.2 5.2	22.65 23.65 1.0 4.4	23.21 24.09 0.9 3.8	23.25 24.16 0.9 3.9	23.10 25.46 2.4 10.2	22.64 25.26 2.6 11.6	22.47 25.29 2.8 12.6	22.15 23.41 1.3 5.7
Solar Thermal AEO2001 RA01 Difference	0.89 0.0 0.0	0.89 0.89 0.0	0.90 0.90 0.0 0.0	0.91 0.93 0.0 2.2	0.94 0.99 0.1 5.3	0.96 1.04 0.1 8.3	0.98 1.08 0.1 10.2	1.01 1.14 0.1 12.9	1.05 1.40 0.4 33.3	1.08 1.66 0.6 53.7	1.11 1.91 0.8 72.1	1.13 2.13 1.0 88.5	1.15 2.36 1.2 105.2	1.17 2.60 1.4 122.2	1.21 2.84 1.6 134.7	1.24 3.08 1.8 148.4	1.26 3.21 2.0 154.8	1.29 3.35 2.1 159.7	1.31 3.49 2.2 166.4	1.34 3.63 2.3 170.9	1.37 3.77 2.4 175.2
Solar Photovoltaic AEO2001 RA01 Difference % Difference	0.04 0.04 0.04 0.0	0.05 0.05 0.0	0.07 0.07 0.0 0.0	0.11 0.12 0.0 9.1	0.15 0.16 0.0 6.7	0.20 0.22 0.0 10.0	0.28 0.28 0.0 7.7	0.31 0.34 0.0 9.7	0.37 0.47 0.1 27.0	0.44 0.63 0.2 43.2	0.51 0.78 0.3 52.9	0.59 0.97 0.4 64.4	0.66 1.15 0.5 74.2	0.74 1.33 0.6 79.7	0.83 1.53 0.7 84.3	0.92 1.73 0.8 88.0	1.01 1.91 0.9 89.1	1.10 2.08 1.0 89.1	1.18 2.26 1.1 91.5	1.27 2.44 1.2 92.1	1.36 2.62 1.3 92.6
Wind AEO2001 RA01 Difference % Difference	5.18 5.18 0.0 0.0	6.62 6.62 0.0 0.0	7.73 7.73 0.0	8.33 9.08 0.8 9.0	8.88 10.38 1.5 16.9	9.42 11.68 2.3 24.0	10.00 13.02 3.0 30.2	10.62 14.39 3.8 35.5	11.26 16.07 4.8 42.7	11.94 17.79 5.9 49.0	12.33 19.23 6.9 56.0	12.52 20.31 7.8 62.2	12.71 21.39 8.7 68.3	12.78 22.34 9.6 74.8	12.78 23.23 10.5 81.8	12.84 24.18 11.3 88.3	12.91 24.53 11.6 90.0	12.93 24.83 11.9 92.0	12.94 25.11 12.2 94.0	13.02 25.48 12.5 95.7	13.10 25.84 12.7 97
TOTALS AEO2001 RA01 Difference % Difference	48.63 48.20 -0.4 -0.9	53.77 55.81 2.0 3.8	58.79 58.59 -0.2 -0.3	56.86 57.63 0.8 1.4	63.96 65.51 1.5 2.4	71.06 75.79 4.7 6.7	75.64 79.56 3.9 5.2	80.61 86.00 5.4 6.7	84.64 93.39 8.7 10.3	87.39 97.71 10.3 11.8	90.81 102.39 11.6 12.8	92.63 106.5 13.9 15.0	94.09 110.2 16.1 17.1	95.58 112.8 17.2 18.0	96.01 114.8 18.8 19.5	96.90 117.3 20.4 21.0	97.50 118.7 21.2 21.8	97.74 121.3 23.6 24.1	97.54 122.2 24.7 25.3	97.73 123.5 25.8 26.3	97.77 122.8 25.1 25.6
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table 11 gas	A17																		•	

Table RA-3. Case 2 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3RA. Total Carbon E	3RA.	Fotal	Carb		missi	ons (I	Mt/a)): Ca	se 2 &	and A	missions (Mt/a): Case 2 and AEO2001	0011									
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum AEO2001 RA01 Difference % Difference	631.2 631.2 0.0 0.0	648.0 648.0 0.0 0.0	661.7 661.7 0.0 0.0	672.4 672.4 0.0 0.0	683.5 682.9 -0.6 -0.1	695.5 695.5 0.0 0.0	707.6 707.6 0.0 0.0	719.5 719.4 -0.1 0.0	730.3 730.2 -0.1 0.0	740.5 740.5 0.0 0.0	750.6 750.4 -0.2 0.0	760.3 760.2 -0.1 0.0	769.5 769.2 -0.3 0.0	780.8 780.7 -0.1 0.0	792.4 792.0 -0.4 -0.1	803.7 803.5 -0.2 0.0	815.0 814.8 -0.2 0.0	825.4 825.1 -0.3 0.0	835.4 835.2 -0.2 0.0	845.5 845.3 -0.2 0.0	856.1 855.9 -0.2 0.0
Natural Gas AEO2001 RA01 Difference	265.4 265.4 0.0 0.0	272.1 272.1 0.0 0.0	279.4 279.4 0.0 0.0	285.3 285.3 0.0 0.0	289.2 289.7 0.5 0.2	291.9 291.9 0.0 0.0	296.2 296.2 0.0 0.0	299.7 299.8 0.1 0.0	303.1 303.4 0.3 0.1	306.1 306.4 0.3 0.1	309.8 310.1 0.3 0.1	312.9 313.2 0.3 0.1	316.6 317.2 0.6 0.2	319.9 320.2 0.3 0.1	323.4 324.0 0.6 0.2	327.5 327.8 0.3 0.1	331.0 331.2 0.2 0.1	334.1 334.4 0.3 0.1	337.2 337.5 0.3 0.1	340.0 340.3 0.3 0.1	343.3 343.5 0.2 0.1
Coal AEO2001 RA01 Difference % Difference	68.9 68.9 0.0 0.0	69.0 69.0 0.0 0.0	68.7 68.7 0.0 0.0	69.4 69.4 0.0 0.0	69.4 69.4 0.0 0.0	69.6 69.6 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.4 -0.1	69.5 69.5 0.0 0.0	69.4 69.4 0.0 0.0	69.5 69.4 -0.1 -0.1	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.5 69.5 0.0 0.0	69.69 69.69 0.0
Other AEO2001 RA01 Difference % Difference	0.0	0.0	0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0
Electricity AEO2001 RA01 Difference % Difference	569.8 569.9 0.1 0.0	587.4 586.7 -0.7	601.6 601.7 0.1 0.0	615.6 615.8 0.2 0.0	625.4 625.8 0.4 0.1	633.1 633.4 0.3 0.0	639.6 638.9 -0.7	653.2 652.5 -0.7 -0.1	661.6 660.0 -1.6 -0.2	667.8 665.5 -2.3 -0.3	679.1 676.0 -3.1 -0.5	687.1 683.6 -3.5 -0.5	695.7 691.1 -4.6 -0.7	706.3 702.0 -4.3 -0.6	715.5 711.1 -4.4 -0.6	727.5 723.2 -4.3 -0.6	735.1 -3.0 -0.4	746.5 742.3 -4.2 -0.6	753.7 750.2 -3.5 -0.5	761.5 757.3 -4.2 -0.6	771.5 767.8 -3.7 -0.5
TOTAL AEO2001 RA01 Difference % Difference	1535 1535 0.0 0.0	1577 1576 -1.0	1611 1611 0.0 0.0	1643 1643 0.0 0.0	1668 1668 0.0 0.0	1690 1690 0.0 0.0	1713 1712 -1.0	1742 1741 -1.0	1765 1763 -2.0	1784 1782 -2.0	1809 1806 -3.0 -0.2	1830 1826 -4.0 -0.2	1851 1847 -4.0	1877 1872 -5.0 -0.3	1901 1897 -4.0 -0.2	1928 1924 -4.0 -0.2	1951 1948 -3.0 -0.2	1976 1971 -5.0	1996 1992 -4.0 -0.2	2017 2013 -4.0 -0.2	2041 2037 -4.0 -0.2
From AEO2001 Table A19	Table 1																				

Table TC-1. Case 3 Capacity from Renewable Technologies and AEO2001

Appendix 1TC. Electric Gener	1TC	. Elec	tric (Gene	rators'		apaci	ty of	Ren	ewab	le Te	chno	Capacity of Renewable Technologies ¹ (GW):	3,1 (G		Case	3 an	d AE	3 and AEO2001	11^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 TC01 Difference % Difference	2.93 2.93 0.0 0.0	2.93 2.93 0.0	2.93 2.93 0.0 0.0	2.93 2.93 0.0 0.0	2.88 2.88 0.0 0.0	3.15 3.85 0.7 22.2	3.34 4.70 1.4 40.7	3.79 5.88 2.1 55.1	4.05 6.77 2.7 67.2	4.21 7.56 3.4 79.6	4.34 7.85 3.5 80.9	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0	4.41 7.85 3.4 78.0
Municipal Solid Waste ³ AEO2001 2.64 TC01 2.64 Difference 0.0 % Difference 0.0	2.64 2.64 2.64 0.0	2.76 2.76 2.76 0.0 0.0	2.78 2.78 0.0 0.0	2.81 2.81 0.0 0.0	3.54 3.21 -0.3 -9.3	3.80 3.73 -0.1 -1.8	3.84 3.77 -0.1 -1.8	3.90 3.83 -0.1 -1.8	3.98 3.91 -0.1 -1.8	4.08 4.01 -0.1	4.20 4.13 -0.1 -1.7	4.34 4.27 -0.1 -1.6	4.51 4.44 -0.1 -1.6	4.53 4.46 -0.1 -1.5	4.55 4.48 -0.1 -1.5	4.57 4.50 -0.1 -1.5	4.64 4.57 -0.1 -1.5	4.66 4.59 -0.1 -1.5	4.68 4.61 -0.1	4.70 4.63 -0.1 -1.5	4.72 4.65 -0.1 -1.5
Biomass AEO2001 TC01 Difference % Difference	1.53 1.53 0.0 0.0	1.54 1.54 0.0 0.0	1.60 1.60 0.0 0.0	1.62 1.62 0.0 0.0	1.66 1.66 0.0 0.0	1.68 1.68 0.0 0.0	1.71 1.71 0.0 0.0	1.76 1.76 0.0 0.0	1.84 1.84 0.0 0.0	1.93 1.93 0.0 0.0	2.04 2.04 0.0 0.0	2.17 2.17 0.0 0.0	2.32 2.32 0.0 0.0	2.32 2.32 0.0 0.0	2.32 2.32 0.0 0.0	2.33 2.33 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0	2.37 2.37 0.0 0.0
Solar Therma AEO2001 TC01 Difference % Difference	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.33 0.0 0.0 0.0	0.34 0.34 0.0 0.0	0.35 0.35 0.0 0.0	0.35 0.35 0.0 0.0	0.36 0.36 0.0 0.0	0.37 0.37 0.0 0.0	0.38 0.38 0.0	0.39 0.39 0.0	0.40 0.40 0.0 0.0	0.40 0.40 0.0 0.0	0.41 0.41 0.0 0.0	0.42 0.0 0.0 0.0	0.43 0.0 0.0	0.44 0.0 0.0 0.0	0.44 0.0 0.0	0.45 0.0 0.0 0.0	0.46 0.0 0.0	0.47 0.0 0.0	0.48 0.0 0.0 0.0
Solar Photovoltaic AEO2001 0.0 TC01 0.0 Difference 0 % Difference 0	0.01 0.01 0.01 0.0	0.02 0.02 0.0	0.03 0.03 0.0	0.05 0.05 0.0 0.0	0.0 0.0 0.0 0.0	0.09	0.11 0.0 0.0	0.13 0.0 0.0	0.15 0.05 0.0	0.18 0.0 0.0	0.21 0.21 0.0 0.0	0.24 0.24 0.0 0.0	0.27 0.27 0.0 0.0	0.30 0.30 0.0 0.0	0.33 0.0 0.0 0.0	0.37 0.37 0.0 0.0	0.40 0.40 0.0 0.0	0.44 0.0 0.0	0.47 0.0 0.0 0.0	0.51 0.51 0.0 0.0	0.54 0.54 0.0 0.0
Wind AEO2001 TC01 Difference % Difference	2.76 2.76 0.0 0.0	3.53 3.53 0.0 0.0	3.80 3.80 0.0 0.0	4.01 4.01 0.0 0.0	4.22 4.42 0.2 4.7	4.43 5.56 1.1 25.5	4.65 9.27 4.6 99.4	4.89 12.06 7.2 146.6	5.14 14.09 9.0 174.1	5.41 15.97 10.6 195.2	5.51 17.97 12.5 226.1	5.58 20.38 14.8 265.2	5.67 23.19 17.5 309.0	5.67 25.45 19.8 348.9	5.67 28.67 23.0 405.6	5.70 32.89 27.2 477.0	5.73 37.64 31.9 556.9	5.73 41.87 36.1 630.7	5.73 45.12 39.4 687.4	5.76 49.01 43.3 750.9	5.78 52.93 47.2 815.7
TOTALS AEO2001 TC01 Difference % Difference	10.20 10.20 0.0 0.0	0.0	11.47 11.47 0.0 0.0	11.76 11.76 0.0 0.0	12.71 12.58 -0.1 -1.0	13.50 15.26 1.8 13.0	14.01 19.92 5.9 42.2	14.84 24.03 9.2 61.9	15.54 27.14 11.6 74.6	16.20 30.04 13.8 85.4	16.70 32.60 15.9 95.2	17.14 35.31 18.2 106.0	17.59 38.48 20.9 118.8	17.65 40.80 23.2 131.2	17.71 44.08 26.4 148.9	17.82 48.38 30.6 171.5	17.99 53.27 35.3 196.1	18.06 57.57 39.5 218.8	18.12 60.88 42.8 236.0	18.22 64.84 46.6 255.9	18.30 68.82 50.5 276.1
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	eneratio 01 Tabl ill gas	n e A17																			

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Table TC-2. Case 3 Generation from Renewable Technologies and AEO2001

Appendix 2TC.	2TC.		Electric Genera	ener	ators	, Ger	ıerati	ion fr	om R	tors' Generation from Renewable Technologies ¹	able '	Techi	golou		(TWh):		se 3	and A	Case 3 and AEO2001	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 TC01 Difference % Difference	13.39 13.39 0.0 0.0	13.56 13.56 0.0 0.0	13.59 13.59 0.0 0.0	13.60 13.60 0.0 0.0	13.56 13.56 0.0 0.0	15.86 21.34 5.5 34.6	17.36 28.02 10.7 61.4	20.89 37.37 16.5 78.9	22.92 44.32 21.4 93.4	24.17 50.56 26.4 109.2	25.27 52.90 27.6 109.3	25.77 52.90 27.1 105.3	25.78 52.91 27.1 105.2	25.78 52.91 27.1 105.2	25.80 52.93 27.1 105.2	25.81 52.93 27.1 105.1	25.81 52.94 27.1 105.1	25.81 52.94 27.1 105.1	25.82 52.95 27.1 105.1	25.82 52.96 27.1 105.1	25.83 52.96 27.1 105.0
Municipal Solid Waste AEO2001 18.36 TC01 18.36 Difference 0.0 % Difference 0.0	d Waste 18.36 18.36 0.0	19.03 19.03 0.0 0.0	19.44 19.44 0.0 0.0	19.64 19.64 0.0 0.0	25.36 22.76 -2.6 -10.3	27.35 26.80 -0.6	27.63 27.08 -0.6 -2.0	28.01 27.47 -0.5 -1.9	28.53 27.99 -0.5 -1.9	29.19 28.65 -0.5 -1.8	30.00 29.46 -0.5 -1.8	30.96 30.42 -0.5 -1.7	32.08 31.54 -0.5 -1.7	32.59 32.05 -0.5	32.74 32.20 -0.5 -1.6	32.88 32.35 -0.5	33.26 32.72 -0.5 -1.6	33.51 32.97 -0.5 -1.6	33.65 33.12 -0.5 -1.6	33.81 33.26 -0.6 -1.6	33.96 33.42 -0.5 -1.6
Biomass AEO2001 TC01 Difference % Difference	10.77 10.57 -0.2 -1.9	13.62 12.54 -1.1	17.06 14.15 -2.9 -17.1	14.27 14.25 0.0 -0.1	15.07 17.76 2.7 17.9	17.27 19.90 2.6 15.2	19.41 20.58 1.2 6.0	19.77 22.09 2.3 11.7	20.51 20.61 0.1 0.5	20.57 22.07 1.5 7.3	21.59 22.73 1.1 5.3	21.66 23.36 1.7 7.8		22.52 23.49 1.0 4.3	22.65 23.14 0.5 2.2	23.21 23.12 -0.1 -0.4	23.25 22.71 -0.5 -2.3	23.10 24.40 1.3 5.6	22.64 22.61 0.0 -0.1	22.47 22.46 0.0 0.0	22.15 21.80 -0.3 -1.6
Solar Thermal AEO2001 TC01 Difference % Difference	0.89 0.89 0.0	0.89 0.0 0.0	0.90 0.90 0.0 0.0	0.91 0.91 0.0 0.0	0.94 0.94 0.0 0.0	0.96 0.96 0.0 0.0	0.98 0.0 0.0	1.01	1.05 1.05 0.0 0.0	1.08 0.0 0.0	1.11 1.11 0.0 0.0	1.13 0.0 0.0	1.15 1.15 0.0 0.0	1.17 1.17 0.0 0.0	1.21 1.21 0.0 0.0	1.24 1.24 0.0 0.0	1.26 1.26 0.0 0.0	1.29 1.29 0.0 0.0	1.31 1.31 0.0 0.0	1.34 1.34 0.0 0.0	1.37 1.37 0.0 0.0
Solar Photovoltaic AEO2001 TC01 Difference % Difference	taic 0.04 0.04 0.0 0.0	0.05 0.00 0.0	0.07 0.00 0.0	0.11 0.0 0.0	0.15 0.0 0.0 0.0	0.20 0.20 0.0 0.0	0.26 0.26 0.0 0.0	0.31 0.31 0.0 0.0	0.37 0.37 0.0 0.0	0.44 0.0 0.0	0.51 0.51 0.0 0.0	0.59 0.59 0.0 0.0	99.0 0.0 0.0	0.74 0.74 0.0 0.0	0.83 0.0 0.0	0.92 0.92 0.0 0.0	1.01 1.01 0.0 0.0	1.10 0.0 0.0	1.18 1.18 0.0	1.27 1.27 0.0 0.0	1.36 1.36 0.0
Wind AEO2001 TC01 Difference % Difference	5.18 5.18 0.0 0.0	6.62 6.62 0.0 0.0	7.73 7.73 0.0	8.33 8.33 0.0 0.0	8.88 9.53 0.6 7.3	9.42 12.99 3.6 37.9	10.00 26.30 16.3 163.0	10.62 36.49 25.9 243.6	11.26 43.91 32.7 290.0	11.94 50.90 39.0 326.3	12.33 58.49 46.2 374.4	12.52 67.16 54.6 436.4	12.71 77.57 64.9 510.3	12.78 86.24 73.5 574.8	12.78 97.59 84.8 663.6		12.91 129.80 116.9 905.4	12.93 144.90 132.0 1020.6	12.94 157.30 144.4 1115.6	13.02 172.20 159.2 1222.6	13.10 186.70 173.6 1325
TOTALS AEO2001 TC01 Difference % Difference	48.63 48.43 -0.2 -0.4	53.77 52.69 -1.1 -2.0	58.79 55.88 -2.9 -4.9	56.86 56.84 0.0 0.0	63.96 64.70 0.7 1.2	71.06 82.19 11.1 15.7	75.64 103.22 27.6 36.5	80.61 124.74 44.1 54.7	84.64 138.25 53.6 63.3	87.39 153.70 66.3 75.9	90.81 165.20 74.4 81.9	92.63 175.6 82.9 89.5	94.09 187.0 93.0 98.8	95.58 196.6 101.0 105.7	96.01 207.9 111.9 116.5	96.90 223.3 126.4 130.4	97.50 240.4 142.9 146.6	97.74 257.6 159.9 163.6	97.54 268.5 170.9 175.2	97.73 283.5 185.8 190.1	97.77 297.6 199.8 204.4
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table Il gas	A17																			

Table TC-3. Case 3 Total Carbon Emissions (Mt/a) and AEO2001

	2020	856.1 855.3 -0.8	343.3 344.0 0.7 0.2	69.6 69.5 -0.1	0.1 0.0 0.0	771.5 744.1 -27.4 -3.6	2041 2013 -28.0 -1.4
	2019	845.5 8 844.8 8 -0.7	1111	69.5 69.4 -0.1	0.1 0.0 0.0	761.5 736.4 725.1 -3.3	2017 1991 -26.0 -1.3
	2018	835.4 833.6 -1.8 -0.2	337.2 338.6 1.4 0.4	69.5 69.4 -0.1	0.1 0.0 0.0	753.7 730.2 -23.5 -3.1	1996 1972 -24.0
	2017	825.4 824.0 -1.4 -0.2	334.1 335.1 1.0 0.3	69.5 69.5 0.0 0.0	0.0	746.5 723.2 -23.3 -3.1	1976 1952 -24.0 -1.2
	2016	815.0 814.7 -0.3 0.0	331.0 331.0 0.0 0.0	69.5 69.4 -0.1	0.1 0.0 0.0	735.1 714.8 -20.3	1951 1930 -21.0 -1.1
	2015	803.7 803.2 -0.5 -0.1	327.5 327.6 0.1 0.0	69.4 69.4 0.0 0.0	0.1 0.0 0.0	727.5 707.9 -19.6 -2.7	1928 1908 -20.0 -1.0
	2014	792.4 791.8 -0.6	323.4 323.9 0.5 0.2	69.5 69.5 0.0 0.0	0.1 0.0 0.0	715.5 697.4 -18.1 -2.5	1901 1883 -18.0 -0.9
	2013	780.8 780.5 -0.3 0.0	319.9 320.2 0.3 0.1	69.5 69.4 -0.1	0.1 0.0 0.0	706.3 688.4 -17.9	1877 1859 -18.0 -1.0
	2012	769.5 769.1 -0.4	316.6 317.0 0.4 0.1	69.5 69.5 0.0 0.0	0.1 0.0 0.0	695.7 678.9 -16.8	1851 1835 -16.0 -0.9
1001	2011	760.3 760.1 -0.2 0.0	312.9 313.1 0.2 0.1	69.4 69.4 0.0 0.0	0.1 0.0 0.0	687.1 672.5 -14.6 -2.1	1830 1815 -15.0 -0.8
nissions (Mt/a): Case 3 and AEO2001	2010	750.6 750.4 -0.2 0.0	309.8 310.1 0.3 0.1	69.5 69.5 0.0 0.0	0.1 0.0 0.0	679.1 665.2 -13.9 -2.0	1809 1795 -14.0 -0.8
and ⁄	2009	740.5 740.4 -0.1 0.0	306.1 306.2 0.1 0.0	69.4 69.4 0.0 0.0	0.1 0.0 0.0	667.8 658.2 -9.6 -1.4	1784 1774 -10.0
rse 3	2008	730.3 730.1 -0.2 0.0	303.1 303.2 0.1 0.0	69.5 69.5 0.0 0.0	0.1 0.0 0.0	661.6 653.7 -7.9 -1.2	1765 1757 -8.0 -0.5
): C	2007	719.5 719.2 -0.3 0.0	299.7 299.7 0.0 0.0	69.5 69.5 0.0 0.0	0.1 0.0 0.0	653.2 645.6 -7.6 -1.2	1742 1734 -8.0 -0.5
Mt/a	2006	707.6 707.6 0.0 0.0	296.2 296.1 -0.1 0.0	69.5 69.5 0.0 0.0	0.1 0.0 0.0	639.6 634.9 -4.7 -0.7	1713 1708 -5.0 -0.3
ions (2002	695.5 695.5 0.0 0.0	291.9 291.9 0.0 0.0	69.69 69.69 0.0 0.0	0.1 0.0 0.0	633.1 631.0 -2.1 -0.3	1690 1688 -2.0 -0.1
miss	2004	683.5 682.9 -0.6 -0.1	289.2 289.8 0.6 0.2	69.4 69.4 0.0 0.0	0.1 0.0 0.0	625.4 624.9 -0.5	1668 1667 -1.0
bon E	2003	672.4 672.4 0.0 0.0	285.3 285.3 0.0 0.0	69.4 69.4 0.0 0.0	0.1 0.0 0.0	615.6 615.6 0.0 0.0	1643 1643 0.0 0.0
Carl	2002	661.7 661.7 0.0 0.0	279.4 279.4 0.0 0.0	68.7 68.7 0.0 0.0	0.0	601.6 602.3 0.7 0.1	1611 1612 1.0 0.1
Total	2001	648.0 648.0 0.0 0.0	272.1 272.1 0.0 0.0	69.0 0.0 0.0	0.0	587.4 587.5 0.1 0.0	1577 1577 0.0 0.0
TC.	2000	631.2 631.2 0.0 0.0	265.4 265.4 0.0 0.0	68.9 0.0 0.0	0.0	569.8 569.8 0.0 0.0	1535 1535 0.0 0.0 Table A
Appendix 3TC. Total Carbon En		Petroleum AEO2001 TC01 Difference % Difference	Natural Gas AEO2001 TC01 Difference % Difference	Coal AEO2001 TC01 Difference % Difference	Other AEO2001 TC01 Difference % Difference	Electricity AEO2001 TC01 Difference % Difference	AEO2001 1535 11: TC01 1535 11: TC01 1535 11: Difference 0.0 % Difference 0.0

Table HP-1. Case 4 Capacity from Renewable Technologies and AEO2001

Appendix 1HP. Electric Generators' Capacity of Renewable Technologies ¹ (GW):	1HP.	Elec	tric (Jener	ators	Cal	gacity	y of R	enew	/able	Tech	golou	gies	(GW		se 4	Case 4 and AEO2001	EO2	001^2		
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 HP01 Difference % Difference	2.93 2.93 0.0 0	2.93 2.93 0.0	2.93 2.93 0.0 0	2.93 2.93 0.0	2.88 2.88 0.0 0	3.15 3.15 0.0 0	3.34 3.34 0.0	3.79 3.79 0.0	4.05 4.05 0.0 0	4.21 4.19 0.0 0	4.34 4.34 0.0 0	4.41 4.39 0.0 0	4.41 4.41 0.0 0	4.41 4.41 0.0 0	4.41 4.41 0.0 0	4.41 4.41 0.0 0	4.41 4.41 0.0 0	4.41 4.41 0.0 0	4.41 0.0 0.0	4.41 0.0 0	4.41 4.41 0.0
Municipal Solid Waste² AEO2001 2.64 HP01 2.64 Difference 0.0 % Difference 0	id Wast 2.64 2.64 0.0	2.76 2.76 0.0 0	2.78 2.78 0.0 0	2.81 2.81 0.0 0	3.54 3.47 -0.1	3.80 3.80 0.0 0	3.84 3.84 0.0 0	3.90 3.90 0.0	3.98 3.98 0.0 0	4.08 4.08 0.0 0	4.20 4.20 0.0 0	4.34 4.34 0.0 0	4.51 4.51 0.0 0	4.53 4.53 0.0 0	4.55 4.55 0.0 0	4.57 4.57 0.0 0	4.64 4.64 0.0 0	4.66 4.66 0.0 0	4.68 4.68 0.0 0	4.70 4.70 0.0 0	4.72 4.72 0.0
Biomass AEO2001 HP01 Difference % Difference	1.53 1.53 0.0 0	1.54 1.54 0.0 0	1.60 1.60 0.0	1.62 1.62 0.0 0	1.66 1.66 0.0 0	1.68 1.68 0.0 0	1.71 1.71 0.0 0	1.76 1.76 0.0	1.84 1.84 0.0 0	1.93 1.93 0.0 0	2.04 2.04 0.0	2.17 2.17 0.0 0	2.32 2.32 0.0 0	2.32 2.32 0.0 0	2.32 2.32 0.0 0	2.33 2.33 0.0	2.37 2.37 0.0 0	2.37 2.37 0.0	2.37 2.37 0.0 0	2.37 2.37 0.0 0	2.37 2.37 0.0
Solar Thermal AEO2001 HP01 Difference % Difference	0.33 0.03 0.0	0.33 0.33 0.0	0.33 0.33 0.0	0.34 0.34 0.0	0.35 0.35 0.0	0.35 0.35 0.0	0.36 0.36 0.0	0.37 0.37 0.0	0.38 0.38 0.0	0.39 0.39 0.0	0.40 0.40 0.0	0.40 0.40 0.0	0.41 0.0 0.0	0.42 0.0 0.0	0.43 0.0 0.0	0.44 0.0 0.0	0.44 0.0 0.0	0.45 0.00 0.0	0.46 0.0 0.0	0.47 0.0 0.0	0.48 0.48 0.0
Solar Photovoltaic AEO2001 0.0 HP01 0.0 Difference 0.0	0.01 0.01 0.01 0.0	0.02 0.02 0.0	0.03 0.03 0.0	0.05 0.05 0.0	0.06 0.00 0.0	0.09	0.11 0.0 0.0	0.13 0.0 0.0	0.15 0.0 0.0	0.18 0.0 0.0	0.21 0.21 0.0	0.24 0.0 0.0	0.27 0.27 0.0 0	0.30 0.30 0.0	0.33 0.33 0.0	0.37 0.0 0.0	0.40 0.40 0.0 0	0.44 0.0 0.0	0.47 0.0 0.0	0.51 0.51 0.0	0.54 0.54 0.0
Wind AEO2001 HP01 Difference % Difference	2.76 2.76 0.0	3.53 3.53 0.0 0	3.80 3.80 0.0 0	4.01 4.01 0.0 0	4.22 4.22 0.0 0	4.43 6.0 0.0	4.65 4.65 0.0 0	4.89 0.0 0	5.14 5.14 0.0 0	5.41 5.41 0.0 0	5.51 5.51 0.0 0	5.58 5.58 0.0 0	5.67 5.67 0.0 0	5.67 5.67 0.0 0	5.67 5.67 0.0 0	5.70 5.70 0.0 0	5.73 5.73 0.0	5.73 5.73 0.0 0	5.73 5.73 0.0 0	5.76 5.76 0.0 0	5.78 5.78 0.0
TOTALS AEO2001 HP01 Difference % Difference	10.20 10.20 0.0	11.11 11.11 0.0 0	11.47 11.47 0.0	11.76 11.76 0.0 0	12.71 12.64 -0.1	13.50 13.50 0.0 0	14.01 14.01 0.0 0	14.84 14.84 0.0 0	15.54 15.54 0.0 0	16.20 16.18 0.0 0	16.70 16.70 0.0	17.14 17.12 0.0	17.59 17.59 0.0	17.65 17.65 0.0	17.71 17.71 0.0 0	17.82 17.82 0.0	17.99 17.99 0.0	18.06 18.06 0.0 0	18.12 18.12 0.0 0	18.22 18.22 0.0	18.30 18.30 0.0
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neratior)1 Tablε ill gas	A17																			

Table HP- 2. Case 4 Generation from Renewable Technologies and AEO2001

Appendix 2HP.	2HP.		Electric Genera	rener	ators	Gel	nerat	ion fr	om R	enew	tors' Generation from Renewable Technologies ¹	Fechr	iologi		(TWh):		se 4 8	and A	Case 4 and AEO2001	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 HP01 Difference % Difference	13.39 13.39 0.0	13.56 13.56 0.0	13.59 13.59 0.0	13.60 13.60 0.0	13.56 13.56 0.0	15.86 15.86 0.0	17.36 17.36 0.0	20.89 20.90 0.0	22.92 22.93 0.0	24.17 24.09 -0.1 0	25.27 25.22 -0.1	25.77 25.68 -0.1	25.78 25.82 0.0	25.78 25.83 0.0	25.80 25.84 0.0 0	25.81 25.85 0.0 0	25.81 25.85 0.0 0	25.81 25.86 0.1	25.82 25.86 0.0	25.82 25.87 0.1	25.83 25.87 0.0
Municipal Solid Waste AEO2001 18.36 HP01 18.36 Difference 0.0 % Difference 0.0	d Waste 18.36 18.36 0.0	19.03 19.03 0.0	19.44 19.44 0.0	19.64 19.64 0.0	25.36 24.80 -0.6	27.35 27.35 0.0	27.63 27.63 0.0	28.01 28.01 0.0	28.53 28.53 0.0	29.19 29.19 0.0 0	30.00 29.99 0.0	30.96 30.95 0.0	32.08 32.07 0.0 0	32.59 32.59 0.0 0	32.74 32.74 0.0 0	32.88 32.88 0.0	33.26 33.25 0.0 0	33.51 33.51 0.0 0	33.65 33.65 0.0 0	33.81 33.81 0.0 0	33.96 33.95 0.0
Biomass AEO2001 HP01 Difference % Difference	10.77 10.35 -0.4 -4	13.62 13.01 -0.6 -4	17.06 17.17 0.1	14.27 14.20 -0.1	15.07 15.11 0.0	17.27 17.10 -0.2 -1	19.41 19.19 -0.2 -1	19.77 21.08 1.3	20.51 20.47 0.0	20.57 21.34 0.8 4	21.59 22.07 0.5	21.66 21.78 0.1	21.71 22.17 0.5	22.52 22.82 0.3	22.65 22.66 0.0 0	23.21 22.58 -0.6	23.25 22.64 -0.6 -3	23.10 24.33 1.2 5	22.64 24.05 1.4 6	22.47 22.55 0.1 0	22.15 22.11 0.0
Solar Thermal AEO2001 HP01 Difference % Difference	0.89 0.0 0.0	0.89 0.0 0.0	0.90 0.90 0.0	0.91 0.0 0.0	0.94 0.0 0.0	0.96 0.0 0.0 0	0.98 0.0 0.0	1.01 1.01 0.0 0	1.05 1.05 0.0	1.08 1.08 0.0 0	11.11 0.0	1.13 1.13 0.0	1.15 1.15 0.0 0	1.17 1.17 0.0 0	1.21 1.21 0.0 0	1.24 1.24 0.0 0	1.26 1.26 0.0	1.29 1.29 0.0	1.31 1.31 0.0	1.34 1.34 0.0	1.37 1.37 0.0
Solar Photovoltaic AEO2001 HP01 Difference % Difference	0.04 0.04 0.04 0.0	0.05 0.05 0.0	0.07 0.07 0.0	0.11 0.0 0.0	0.15 0.0 0.0	0.20 0.20 0.0 0.0	0.26 0.26 0.0	0.31 0.0 0.0	0.37 0.0 0.0	0.44 0.0 0.0	0.51 0.51 0.0	0.59 0.0 0.0	0.0 0.0 0.0	0.74 0.0 0.0	0.83 0.0 0.0	0.92 0.92 0.0	1.01 1.01 0.0	1.10 1.10 0.0	1.18 1.18 0.0	1.27 1.27 0.0 0	1.36 1.36 0.0
Wind AEO2001 HP01 Difference % Difference	5.18 5.18 0.0 0	6.62 6.62 0.0 0	7.73 7.73 0.0	8.33 8.33 0.0	8.88 8.88 0.0	9.42 9.42 0.0	10.00	10.62 10.62 0.0	11.26 11.26 0.0	11.94 11.94 0.0 0	12.33 12.33 0.0	12.52 12.52 0.0 0	12.71 12.71 0.0	12.78 12.78 0.0	12.78 12.78 0.0	12.84 12.84 0.0 0	12.91 12.91 0.0	12.93 12.93 0.0 0	12.94 12.93 0.0 0	13.02 13.02 0.0 0	13.10 13.10 0.0
TOTALS AEO2001 HP01 Difference % Difference	48.63 48.21 -0.4 -1	53.77 53.16 -0.6	58.79 58.90 0.1	56.86 56.79 -0.1	63.96 63.44 -0.5	71.06 70.89 -0.2 0	75.64 75.42 -0.2 0	80.61 81.93 1.3	84.64 84.61 0.0 0	87.39 88.08 0.7	90.81 91.23 0.4 0	92.63 92.7 0.0	94.09 94.6 0.5	95.58 95.9 0.4 0	96.01 96.1 0.0	96.90 96.3 -0.6	97.50 96.9 -0.6	97.74 99.0 1.3	97.54 99.0 1.4	97.73 97.9 0.1 0	97.77 97.8 0.0
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table 1 gas	A17																			

Table HP-3. Case 4 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3HP. Total Carbon E	3НР.	Total	Carb		missi	ons (Mt/a)): Ca	se 4 £	and A	missions (Mt/a): Case 4 and AEO2001	0011									
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum AEO2001 HP01 Difference % Difference	631.2 631.2 0.0 0	648.0 648.0 0.0 0	661.7 661.7 0.0 0	672.4 672.5 0.1	683.5 683.6 0.1 0	695.5 695.6 0.1	707.6 707.8 0.2 0	719.5 719.5 0.0	730.3 730.5 0.2 0	740.5 740.8 0.3	750.6 750.9 0.3	760.3 760.6 0.3 0	769.5 769.6 0.1	780.8 780.9 0.1	792.4 792.5 0.1	803.7 804.0 0.3 0	815.0 815.3 0.3	825.4 825.7 0.3	835.4 835.7 0.3	845.5 845.8 0.3 0	856.1 856.5 0.4
Natural Gas AEO2001 HP01 Difference % Difference	265.4 265.4 0.0 0	272.1 272.1 0.0	279.4 279.4 0.0 0	285.3 285.5 0.2 0	289.2 289.5 0.3 0	291.9 292.4 0.5 0	296.2 297.0 0.8	299.7 300.8 1.1 0	303.1 304.5 1.4 0	306.1 307.7 1.6 1.6	309.8 311.7 1.9	312.9 314.8 1.9	316.6 318.8 2.2 1	319.9 322.1 2.2 1	323.4 325.6 2.2 1	327.5 329.6 2.1	331.0 333.1 2.1	334.1 336.4 2.3	337.2 339.6 2.4 1	340.0 342.6 2.6 1	343.3 345.9 2.6
Coal AEO2001 HP01 Difference % Difference	68.9 68.9 0.0 0	0.69 0.0 0.0	68.7 68.7 0.0 0	69.4 69.5 0.1	69.4 69.6 0.2 0	69.6 69.9 0.3 0	69.5 69.9 0.4	69.5 70.0 0.5	69.5 70.0 0.5	69.4 70.0 0.6	69.5 70.2 0.7	69.4 70.1 0.7	69.5 70.2 0.7	69.5 70.2 0.7	69.5 70.2 0.7	69.4 70.2 0.8 1	69.5 70.2 0.7	69.5 70.2 0.7	69.5 70.2 0.7	69.5 70.2 0.7	69.6 70.3 0.7
Other AEO2001 HP01 Difference % Difference	0.0	0.0	0.0	0.0 0.0 0.0	0.1 0.0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1 0.0 0	0.1 0.0 0	0.0	0.0	0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0
Electricity AEO2001 HP01 Difference	569.8 569.9 0.1	587.4 587.5 0.1	601.6 601.5 -0.1	615.6 614.8 -0.8	625.4 624.5 -0.9	633.1 631.1 -2.0	639.6 635.5 -4.1	653.2 648.3 -4.9	661.6 656.2 -5.4 -1	667.8 662.2 -5.6 -1	679.1 671.5 -7.6 -1	687.1 679.5 -7.6	695.7 687.6 -8.1	706.3 697.7 -8.6	715.5 709.1 -6.4	727.5 721.5 -6.0	735.1 729.8 -5.3	746.5 740.1 -6.4	753.7 747.8 -5.9	761.5 754.8 -6.7	771.5 764.1 -7.4 -1
TOTAL AEO2001 HP01 Difference % Difference	1535 1536 1.0 0.1	1577 1577 0.0 0.0	1611 1611 0.0 0.0	1643 1642 -1.0	1668 1667 -1.0	1690 1689 -1.0	1713 1710 -3.0 -0.2	1742 1739 -3.0	1765 1761 -4.0 -0.2	1784 1781 -3.0 -0.2	1809 1804 -5.0 -0.3	1830 1825 -5.0 -0.3	1851 1846 -5.0 -0.3	1877 1871 -6.0	1901 1898 -3.0 -0.2	1928 1925 -3.0 -0.2	1951 1948 -3.0 -0.2	1976 1972 -4.0	1996 1993 -3.0 -0.2	2017 2014 -3.0 -0.1	2041 2037 -4.0 -0.2
From AEO2001 Table A19	1 Table	419																			

Table HP-4. Case 4 Fuel Consumption by Sector and Fuel Type and AEO2001

Appendix 4HP. Fuel Consumptio	4HP.	Fuel	Cons	duns	☲	by Sector and Fuel Type (Quads):	ctor	and F	uel T	ype	(Qua	_	Case	Case 4 and		AEO2001	_				
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential Petroleum	oleum.	,	,	,			,														
AE02001 HP01	1.44 1.44	1.50	1.49 1.49	1.48 4.1 48	1.45 1.45	1.42	1.40	1.37	1.35	1.32	1.29	1.28	1.27	1.26	1.26	1.24	1.24	1.22	1.22	1.21	1.21
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
ਫ਼	Natural Gas																				
AEO2001	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.55	5.61	5.65	5.69	5.75	5.82	5.87	5.93	5.99	90.9	6.11	6.17	6.23	6.30
HP01	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.56	5.62	5.65	5.70	5.76	5.83	5.88	5.94	5.99	6.07	6.11	6.17	6.23	6.31
Difference % Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kesidential Coal																					
AEO2001	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
HP01	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Difference % Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Docidontial Floatniaity	twinity,2																				T
	206	707	111	20. 1	0.0	05.6	9 60	17.67	07.1	70 7	707	70.5	21.7	103	00 3	LC 3	2 46	63.3	17.5	01.3	00 3
AEU2001 HP01	3.96	4.06	4.17	4.2.4 2.80	4.39 4.40	4.50	4.58	4.67	4. 4 8/ 8/	4.80	4.96	5.04 4.05	4 7	5.20	5.28	5.37	5.40	5.55	5.62	5.70	5.80
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial Pet	Petroleum																				
AEO2001	0.59	0.63	0.64	0.65	0.65	99.0	99.0	99.0	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	99.0	99.0	99.0	0.66
HP01	0.59	0.63	0.64	0.65	0.65	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.66	0.66	0.66	0.66	0.66
Unrerence % Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1	0.0	0.0	0.0	0.0
Commercial Natural Cas	inral Ca	54																			I
AEO2001	3 2 7 3 3 7 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 3 7 3 7 3 3 3 7 3 3 7 3		3.52	3.63	3 68	3.71	3.75	3 70	3 87	3.85	3 88	3 07	3 96	3 00	4 02	4.05	4 07	4.00	411	4 12	4.13
HP01	3.27	3.39	3.52	3.62	3.68	3.72	3.75	3.79	3.83	3.86	3.89	3.93	3.97	4.00	4.03	4.06	4.09	4.11	4.13	4.15	4.16
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Commercial Coa	al.																				
AEO2001	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	80.0	80.0	80.0	0.08
HP01	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Dillerence					0					0									>	>	
Commercial Electricity	ctricity_			,																	
AEO2001	3.78	3.90	4.03	4.13	4.23	4.35	4.45	4.57	4.68 8.68	87.4	4.89	4.98	5.08 5.08	5.17	5.25	5.32	5.39	5.45	5.51	5.56	5.61
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table HP-4 Cont'd. Case 4 Fuel Consumption by Sector and Fuel Type and AEO2001

Appendix 4HP cont'd. Fuel Consumption by Sector and Fuel Type ¹ (Quads): Case 4 and AEO2001	4HP	cont'	d. Fu	el Co	usu	ptior	ı by §	Sector	r and	Fuel	Type	3 <mark>7(Qu</mark>	ads):	Cas	e 4 a	nd A	E026)01			
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Industrial Petroleum	oleum																				
AEO2001 HP01	9.31	9.44 9.44	9.55	9.67 9.67	9.82	9.95	10.07 10.04	10.23 10.23	10.34	10.44	10.55	10.63 10.64	10.69	10.85	11.00	11.14	11.28	11.39	11.51	11.64	11.77
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial Natural Gas	ıral Gas																				
AEO2001	99.6	9.84	10.04	10.26	10.33	10.43	10.61	10.76	10.87	10.98	11.11	11.21	11.35	11.47	11.59	11.76	11.88	12.00	12.11	12.22	12.34
HP01	99.6	9.83	10.04	10.27	10.35	10.46	10.70	10.82	10.96	11.07	11.23	11.33	11.47	11.60	11.72	11.89	12.01	12.15	12.27	12.37	12.50
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2
% Difference	0	0	0	0	0	0	_	-	_	-	_	_	_	-	-	-	_	_	_	_	_
Industrial Coal																					
AE02001	2.61	2.61	2.59	2.62	2.62	2.62	2.62	2.62	2.62	2.61	2.62	2.61	2.61	2.61	2.62	2.61	2.61	2.61	2.61	2.61	2.62
HP01	2.61	2.61	2.59	2.62	2.63	2.64	2.63	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.65
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	T
Industrial Electricity	tricity ²																				
AEO2001	3.68	3.72	3.78	3.83	3.85	3.90	3.97	4.03	4.08	4.13	4.18	4.23	4.27	4.33	4.40	4.47	4.53	4.60	4.66	4.74	4.81
HP01	3.68	3.72	3.78	3.81	3.82	3.86	3.91	3.95	3.99	4.02	4.06	4.10	4.15	4.20	4.26	4.33	4.39	4.45	4.51	4.58	4.66
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.1
% Difference	0			-	7	-	7-	7-	7-	ņ	ŗ.	٠	٠	ر ا	ņ	ŗ.		ņ	ن ا	ç-	j.
Total																					
AE02001	43.37	44.35	45.19	46.00	46.57	47.12	47.74	48.37	48.94	49.41	49.96	50.44	50.98	51.55	52.14	52.74	53.31	53.79	54.30	54.82	55.38
HP01	43.37	44.33	45.19	46.00	46.59	47.15	47.75	48.38	48.99	49.46	50.01	50.50	51.05	51.60	52.18	52.79	53.36	53.87	54.37	54.90	55.49
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
'From AEO2001 Table A2	Table A2																				
'Excludes losses																					
'As expected, overall consumption decreases when electricity	rall consu	mption dec	reases wh	ien electri		losses are included	nded														

Table NG- 1. Case 5 Capacity from Renewable Technologies and AEO2001

Appendix 1NG. Electric Generators' Capacity of Renewable Technologies ¹ (GW):	1NG	f. Ele	tric	Gene	rator	s, C	apaci	ty of	Rene	wab	le Te	chno	logie	s ¹ (G		Case	5 an	5 and AEO2001 ²	0200	11^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 NG01 Difference	2.93 2.93 0.0 0.0	2.93 2.93 0.0	2.93 2.93 0.0 0.0	2.93 2.93 0.0 0.0	2.88 2.88 0.0 0.0	3.15 3.15 0.0 0.0	3.34 3.34 0.0 0.0	3.79 3.79 0.0 0.0	4.05 4.05 0.0 0.0	4.21 4.21 0.0 0.0	4.34 4.34 0.0 0.0	4.41 4.53 0.1 2.7	4.41 4.78 0.4 8.4	4.41 4.92 0.5 11.6	4.41 4.92 0.5 11.6	4.41 4.93 0.5 11.8	4.41 4.93 0.5 11.8	4.41 4.93 0.5 11.8	4.41 4.93 0.5 11.8	4.41 4.93 0.5 11.8	4.41 4.93 0.5 11.8
Municipal Solid Waste ² AEO2001 2.64 2 NG01 2.64 2 Difference 0.0 0.0 % Difference 0.0 0.0	2.64 2.64 2.64 0.0 0.0	2.76 2.76 0.0 0.0	2.78 2.78 0.0 0.0	2.81 2.81 0.0 0.0	3.54 3.54 0.0 0.0	3.80 3.80 0.0 0.0	3.84 3.84 0.0 0.0	3.90 3.90 0.0 0.0	3.98 3.98 0.0 0.0	4.08 4.08 0.0 0.0	4.20 4.47 0.3 6.4	4.34 4.70 0.4 8.3	4.51 4.87 0.4 8.0	4.53 4.90 0.4 8.2	4.55 4.93 0.4 8.4	4.57 4.95 0.4 8.3	4.64 5.02 0.4 8.2	4.66 5.04 0.4 8.2	4.68 5.06 0.4 8.1	4.70 5.08 0.4 8.1	4.72 5.10 0.4 8.1
Biomass AEO2001 NG01 Difference % Difference	1.53 1.53 0.0 0.0	1.54 1.54 0.0 0.0	1.60 1.60 0.0	1.62 1.62 0.0 0.0	1.66 1.66 0.0 0.0	1.68 1.68 0.0 0.0	1.71 1.71 0.0 0.0	1.76 1.76 0.0 0.0	1.84 1.84 0.0	1.93 1.93 0.0 0.0	2.04 2.04 0.0 0.0	2.17 2.17 0.0 0.0	2.32 2.32 0.0 0.0	2.32 2.36 0.0 1.7	2.32 2.45 0.1 5.6	2.33 2.52 0.2 8.2	2.37 2.79 0.4 17.7	2.37 3.04 0.7 28.3	2.37 3.11 0.7 31.2	2.37 3.11 0.7 31.2	2.37 3.11 0.7 31.2
Solar Therma AEO2001 NG01 Difference % Difference	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.34 0.34 0.0 0.0	0.35 0.35 0.0 0.0	0.35 0.35 0.0 0.0	0.36 0.36 0.0 0.0	0.37 0.37 0.0 0.0	0.38 0.38 0.0	0.39 0.39 0.0	0.40 0.40 0.0 0.0	0.40 0.40 0.0 0.0	0.41 0.0 0.0	0.42 0.42 0.0 0.0	0.43 0.0 0.0 0.0	0.44 0.44 0.0 0.0	0.44 0.0 0.0	0.45 0.0 0.0	0.46 0.0 0.0	0.47 0.0 0.0	0.48 0.48 0.0 0.0
Solar Photovoltaic AEO2001 0.0 NG01 0.0 Difference 0. % Difference 0.	0.01 0.01 0.01 0.0	0.02 0.02 0.0	0.03 0.03 0.0	0.05 0.05 0.0 0.0	0.06 0.0 0.0	0.09	0.11 0.0 0.0	0.13 0.13 0.0 0.0	0.15 0.15 0.0 0.0	0.18 0.0 0.0 0.0	0.21 0.21 0.0 0.0	0.24 0.24 0.0 0.0	0.27 0.27 0.0 0.0	0.30 0.30 0.0 0.0	0.33 0.0 0.0 0.0	0.37 0.37 0.0 0.0	0.40 0.40 0.0 0.0	0.0 0.0 0.0	0.47 0.00 0.0	0.51 0.51 0.0 0.0	0.54 0.54 0.0 0.0
Wind AEO2001 NG01 Difference % Difference	2.76 2.76 0.0 0.0	3.53 3.53 0.0 0.0	3.80 3.80 0.0 0.0	4.01 4.01 0.0 0.0	4.22 4.22 0.0 0.0	4.43 4.43 0.0 0.0	4.65 4.65 0.0 0.0	4.89 4.89 0.0 0.0	5.14 5.14 0.0 0.0	5.41 5.41 0.0 0.0	5.51 5.51 0.0 0.0	5.58 5.58 0.0 0.0	5.67 5.67 0.0 0.0	5.67 5.67 0.0 0.0	5.67 5.72 0.0 0.9	5.70 5.78 0.1 1.4	5.73 5.83 0.1 1.7	5.73 5.83 0.1 1.7	5.73 5.83 0.1 1.7	5.76 5.83 0.1 1.2	5.78 5.83 0.0 0.9
TOTALS AEO2001 NG01 Difference % Difference	10.20 10.20 0.0 0.0	11.11 0.0 0.0	11.47 11.47 0.0 0.0	11.76 11.76 0.0 0.0	12.71 12.71 0.0 0.0	13.50 13.50 0.0 0.0	14.01 14.01 0.0 0.0	14.84 14.84 0.0 0.0	15.54 15.54 0.0 0.0	16.20 16.20 0.0 0.0	16.70 16.97 0.3 1.6	17.14 17.62 0.5 2.8	17.59 18.32 0.7 4.2	17.65 18.57 0.9 5.2	17.71 18.78 1.1 6.0	17.82 18.99 1.2 6.6	17.99 19.41 1.4 7.9	18.06 19.73 1.7 9.2	18.12 19.86 1.7 9.6	18.22 19.93 1.7 9.4	18.30 19.99 1.7 9.2
¹ Excludes cogeneration ² From AEO2001 Table A17 ³ Includes landfill gas	eneratio 01 Tabl ill gas	n e A17																			

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Table NG- 2. Case 5 Generation from Renewable Technologies and AEO2001

Appendix 2NG. Electric Genera	2NG.	Elec	tric (Jenei	ator	s' Ge	nerat	ion fi	ıtors' Generation from Renewable Technologies ¹	kenew	/able	Tech	nolog		(TWh):		se 5	and ∤	Case 5 and AEO2001 ²	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 NG01 Difference	13.39 13.39 0.0 0.0	13.56 13.56 0.0 0.0	13.59 13.59 0.0 0.0	13.60 13.60 0.0 0.0	13.56 13.56 0.0 0.0	15.86 15.86 0.0 0.0	17.36 17.36 0.0 0.0	20.89 20.89 0.0 0.0	22.92 22.92 0.0 0.0	24.17 24.17 0.0 0.0	25.27 25.27 0.0 0.0	25.77 26.71 0.9 3.6	25.78 28.74 3.0 11.5	25.78 29.79 4.0 15.6	25.80 29.80 4.0 15.5	25.81 29.95 4.1 16.0	25.81 29.95 4.1 16.0	25.81 29.96 4.2 16.1	25.82 29.96 4.1 16.0	25.82 29.97 4.2 16.1	25.83 29.97 4.1 16.0
Municipal Solid Waste AEO2001 18.36 NG01 18.36 Difference 0.0 % Difference 0.0	d Waste 18.36 18.36 0.0 0.0	19.03 19.03 0.0 0.0	19.44 19.44 0.0 0.0	19.64 19.64 0.0 0.0	25.36 25.36 0.0 0.0	27.35 27.35 0.0 0.0	27.63 27.62 0.0 0.0	28.01 28.01 0.0 0.0	28.53 28.53 0.0 0.0	29.19 29.19 0.0 0.0	30.00 32.15 2.2 7.2	30.96 33.78 2.8 9.1	32.08 34.96 2.9 9.0	32.59 35.48 2.9 8.9	32.74 35.70 3.0 9.0	32.88 35.91 3.0 9.2	33.26 36.29 3.0 9.1	33.51 36.54 3.0 9.0	33.65 36.69 3.0 9.0	33.81 36.83 3.0 8.9	33.96 36.97 3.0 8.9
Biomass AEO2001 NG01 Difference % Difference	10.77 10.77 0.0 0.0	13.62 13.62 0.0 0.0	17.06 17.06 0.0 0.0	14.27 14.27 0.0 0.0	15.07 15.07 0.0 0.0	17.27 17.27 0.0 0.0	19.41 19.35 -0.1	19.77 21.51 1.7 8.8	20.51 23.98 3.5 16.9	20.57 26.29 5.7 27.8	21.59 24.19 2.6 12.0	21.66 29.01 7.4 33.9	21.71 23.45 1.7 8.0	22.52 21.41 -1.1 -4.9	22.65 19.00 -3.7 -16.1	23.21 18.65 -4.6 -19.6	23.25 19.03 -4.2 -18.2	23.10 19.88 -3.2 -13.9	22.64 19.92 -2.7 -12.0	22.47 19.76 -2.7 -12.1	22.15 19.32 -2.8 -12.8
Solar Thermal AEO2001 NG01 Difference % Difference	0.89 0.0 0.0	0.89 0.0 0.0	0.90 0.90 0.0 0.0	0.91 0.91 0.0 0.0	0.94 0.94 0.0	0.96 0.0 0.0 0.0	0.98 0.98 0.0	1.01	1.05 1.05 0.0 0.0	1.08 0.0 0.0	1.11 0.0	1.13 1.13 0.0 0.0	1.15 1.15 0.0 0.0	1.17 1.17 0.0 0.0	1.21 1.21 0.0 0.0	1.24 1.24 0.0 0.0	1.26 1.26 0.0 0.0	1.29 1.29 0.0 0.0	1.31 1.31 0.0 0.0	1.34 1.34 0.0	1.37 1.37 0.0 0.0
Solar Photovoltaic AEO2001 NG01 Difference % Difference	taic 0.04 0.04 0.0 0.0	0.05 0.05 0.0	0.07 0.07 0.0 0.0	0.11 0.0 0.0	0.15 0.0 0.0 0.0	0.20 0.20 0.0 0.0	0.26 0.26 0.0 0.0	0.31 0.31 0.0 0.0	0.37 0.37 0.0 0.0	0.44 0.0 0.0	0.51 0.51 0.0 0.0	0.59 0.59 0.0 0.0	99.0 9.0 0.0	0.74 0.74 0.0 0.0	0.83 0.0 0.0	0.92 0.92 0.0 0.0	1.01 1.01 0.0 0.0	1.10 0.0 0.0	1.18 1.18 0.0 0.0	1.27 1.27 0.0 0.0	1.36 1.36 0.0 0.0
Wind AEO2001 NG01 Difference % Difference	5.18 5.18 0.0 0.0	6.62 6.62 0.0 0.0	7.73 7.73 0.0	8.33 8.33 0.0 0.0	8.88 8.88 0.0 0.0	9.42 9.42 0.0 0.0	10.00 10.00 0.0 0.0	10.62 10.62 0.0 0.0	11.26 11.26 0.0 0.0	11.94 11.94 0.0 0.0	12.33 12.33 0.0 0.0	12.52 12.52 0.0 0.0	12.71 12.71 0.0 0.0	12.78 12.78 0.0 0.0	12.78 12.93 0.2 1.2	12.84 13.08 0.2 1.9	12.91 13.22 0.3 2.4	12.93 13.24 0.3 2.4	12.94 13.24 0.3 2.3	13.02 13.24 0.2 1.7	13.10 13.24 0.1
TOTALS AEO2001 NG01 Difference % Difference	48.63 48.63 0.0 0.0	53.77 53.77 0.0 0.0	58.79 58.79 0.0 0.0	56.86 56.86 0.0 0.0	63.96 63.96 0.0 0.0	71.06 71.06 0.0 0.0	75.64 75.57 -0.1	80.61 82.35 1.7 2.2	84.64 88.11 3.5 4.1	87.39 93.11 5.7 6.5	90.81 95.56 4.8 5.2	92.63 103.7 11.1 12.0	94.09 101.7 7.6 8.1	95.58 101.4 5.8 6.1	96.01 99.5 3.5 3.6	96.90 99.8 2.8 2.9	97.50 100.8 3.3 3.3	97.74 102.0 4.3 4.4	97.54 102.3 4.8 4.9	97.73 102.4 4.7 4.8	97.77 102.2 4.5 4.6
¹ Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table II gas	A17																		'	

Table NG-3. Case 5 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3NG. Total Carbon En	NG.	Total	Carb	on E	missi	ons (I	Mt/a)	: Ca	se 5 a	nd A	missions (Mt/a): Case 5 and AEO2001	001^{1}									
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum AEO2001 NG01 Difference % Difference	631.2 631.2 0.0 0.0	648.0 648.0 0.0 0.0	661.7 661.7 0.0 0.0	672.4 672.4 0.0 0.0	683.5 683.5 0.0 0.0	, ,				740.5 742.1 1.6 0.2		760.3 763.3 3.0 0.4	769.5 773.0 3.5 3.5 0.5	780.8 784.8 4.0 0.5	792.4 796.1 3.7 0.5	803.7 805.8 2.1 0.3	815.0 813.5 -1.5 -0.2	825.4 824.2 -1.2 -0.1	835.4 8 834.2 8 -1.2	845.5 843.7 -1.8 -0.2	856.1 855.2 -0.9 -0.1
Natural Gas AEO2001 NG01 Difference % Difference	265.4 265.4 0.0 0.0	272.1 272.1 0.0 0.0	279.4 279.4 0.0 0.0	285.3 285.3 0.0 0.0	289.2 289.2 0.0 0.0	291.9 291.9 0.0 0.0	296.2 2 293.1 2 -3.1 -1.0	299.7 3 293.7 2 -6.0 -2.0	303.1 294.1 -9.0 -3.0	306.1 293.8 -12.3 -4.0	309.8 294.2 -15.6 -5.0	312.9 292.9 -20.0 -6.4	316.6 293.0 -23.6 -7.5	319.9 292.3 -27.6 -8.6	323.4 293.1 -30.3 -9.4	327.5 295.0 -32.5 -9.9	331.0 298.7 -32.3 -9.8	334.1 297.7 -36.4 -10.9	337.2 297.9 -39.3 -11.7	340.0 298.3 -41.7	343.3 297.8 -45.5 -13.3
Coal AEO2001 NG01 Difference % Difference	68.9 68.9 0.0 0.0	69.0 69.0 0.0 0.0	68.7 68.7 0.0 0.0	69.4 69.4 0.0 0.0	69.4 69.4 0.0 0.0	9.69 9.69 0.0 0.0	69.5 69.6 0.1 0.1	69.5 69.7 0.2 0.3	69.5 69.8 0.3 0.4	69.4 69.8 0.4 0.6	69.5 70.0 0.5 0.7	69.4 70.0 0.6 0.9	69.5 70.1 0.6 0.9	69.5 70.2 0.7 1.0	69.5 70.3 0.8 1.2	69.4 70.3 0.9 1.3	69.5 70.3 0.8 1.2	69.5 70.4 0.9 1.3	69.5 70.5 1.0	69.5 70.5 1.0 1.4	69.6 70.7 1.1 1.6
Other AEO2001 NG01 Difference % Difference	0.0	0.0	0.0	0.0 0.0 0.0	0.0	0.1 0.0 0.0	0.0	0.0	0.0	0.1 0.0 0.0	0.0 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0
Electricity AEO2001 NG01 Difference % Difference	569.8 569.8 0.0 0.0	587.4 587.4 0.0 0.0	601.6 601.6 0.0 0.0	615.6 615.6 0.0 0.0	625.4 625.4 0.0 0.0	633.1 6 633.1 6 0.0 0.0	639.6 633.6 -6.0 -0.9	653.2 6 646.2 6 -7.0 -1.1	661.6 6 654.3 6 -7.3	667.8 660.7 -7.1 -1.1	679.1 675.9 -3.2 -0.5	692.6 5.5 0.8	695.7 708.4 12.7 1.8	706.3 726.7 20.4 2.9	715.5 741.6 26.1 3.6	727.5 758.4 30.9 4.2	735.1 769.8 34.7 4.7	746.5 779.7 33.2 4.4	753.7 785.8 32.1 4.3	761.5 797.5 36.0 4.7	808.6 37.1 4.8
AEO2001 1535 11: NG01 1535 11: Difference 0.0 % Difference 0.0 From AEO2001 Table A19	1535 1535 0.0 0.0	1577 1577 0.0 0.0	1611 1611 0.0 0.0	1643 1643 0.0 0.0	1668 1668 0.0 0.0	1690 1690 0.0 0.0	1713 1704 -9.0 -0.5	1742 1730 -12.0 .	1765 1750 -15.0	1784 1766 -18.0 -1.0	1809 1793 -16.0 -0.9	1830 1819 -11.0 -0.6	1851 1845 -6.0 -0.3	1877 1874 -3.0 -0.2	1901 1901 0.0 0.0	1928 1930 2.0 0.1	1951 1952 1.0 0.1	1976 1972 -4.0	1996 1988 -8.0 -0.4	2017 2010 -7.0 -0.3	2041 2032 -9.0 -0.4

Table WN-1. Case 6 Capacity from Renewable Technologies and AEO2001

Appendix 1WN. Electric Gene	1 WI	V. Ele	ctric	Gen	erators'	rs' C	Capacity of	ity of	Ren	Renewable	ole Te	Technologies ¹ (GW):	ologie	.s. (G	;W):	Cas	Case 6 and AEO2001	ld AF	020	01^2	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal	7.02	2 02	2 03	7.02	00 (2 15	2 2 4	3 70	4 05	10.4	1 24	1 7	14.4	14.4	4 4 1	4.41	14	-	17	1 4 1	4.41
WN01	2.93	2.93	2.93	2.93	2.88	3.78	4.51	5.67	6.54	7.14	7.40	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42	7.42
Difference % Difference	0.0	0.0	0.0	0.0	0.0	0.6	1.2 35.0	1.9	2.5	2.9 69.6	3.1	3.0	3.0	3.0	3.0 68.3	3.0	3.0	3.0	3.0	3.0	3.0
Municipal Sol	Solid Waste	te																			
01	2.64	2.76	2.78	2.81	3.54	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
WN01	2.64	2.76	2.78	2.81	3.26	3.80	3.84	3.90	3.98	4.08	4.20	4.34	4.51	4.53	4.55	4.57	4.64	4.66	4.68	4.70	4.72
Difference % Difference	0.0	0.0	0.0	0.0	-0.3 -7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Riomace	2.5	2.5	2.	2.5	2:	2	2.	2.5	2.5	2.	2.	2.5	9.0	2.5	2.	2	2.5	2.	2:	2.	2
AEO2001	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
WN01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76	1.84	1.93	2.04	2.17	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Therma	_																				
AEO2001	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
WN01	0.33	0.33	0.33	0.34	0.35	0.35	0.36	0.37	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar Photovoltaic	oltaic																				
AEO2001	0.01	0.02	0.03	0.05	0.06	0.09	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
WN01	0.01	0.05	0.03	0.05	90.0	0.0	0.11	0.13	0.15	0.18	0.21	0.24	0.27	0.30	0.33	0.37	0.40	0.44	0.47	0.51	0.54
Difference % Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	9.0	0.0	0.0	9.0	2.0	0.0	0.0	0.0	0.0	9.0	2.0	3.	0.0	9.	0.0	2.0	2.0	2.0	9.
W III U	0	7	000	4 0 1	00	7	100	00 4	7 1 7	17	100	0.0	17.5	2	17.4		1	C L 1	7	70.0	000
AEO2001 WN01	2.76	3.53	3.80	4.01	4.22 4.49	5.48	9.61	4.89 12.34	5.14 15.03	5.41 18.25	21.15	24.47	28.33	32.92	36.74	41.22	5.73 45.26	50.28	53.89	5.76 60.92	5.78 65.71
Difference	0.0	0.0	0.0	0.0	0.3	1.1	5.0	7.5	6.6	12.8	15.6	18.9	22.7	27.3	31.1	35.5	39.5	44.6	48.2	55.2	59.9
% Difference	0.0	0.0	0.0	0.0	6.4	23.7	106.7	152.4	192.4	237.3	283.8	338.5	399.6	480.6	548.0	623.2	6.689	777.5	840.5	922.6	1036.9
TOTALS																					
AEO2001	10.20	11.11	11.47	11.76	12.71	13.50	14.01	14.84	15.54	16.20	16.70	17.14	17.59	17.65	17.71	17.82	17.99	18.06	18.12	18.22	18.30
WNOI	10.20	11.11	11.4/	0.0	12.70	15.18	20.14	24.17	26.72	51.97	35.40	39.04	45.26	20.2	24.19	20.55	60.53	29.69	69.29	/6.39 58.3	81.24
% Difference	0.0	0.0	0.0	0.0	-0.0	12.4	43.8	62.9	79.7	97.3	112.0	127.8	145.9	171.4	34.1 192.4	216.2	236.5	263.3	282.4	319.3	343.9
Excludes cogeneration	eneratio	n 2 4 1 7																			

²From AEO2001 Table A17 fincludes landfill gas

Table WN-2. Case 6 Generation from Renewable Technologies and AEO2001

Appendix 2WN.	2WN.	Electric Gener	tric (Jene	rator	s' Ge	nera	tion f	rom]	ators' Generation from Renewable Technologies ¹	vable	Tech	olou	gies¹ ((TWh):		ase 6	and	Case 6 and AEO2001	001^2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001 WN01 Difference % Difference	13.39 13.39 0.0 0.0	13.56 13.56 0.0 0.0	13.59 13.59 0.0 0.0	13.60 13.60 0.0 0.0	13.56 13.56 0.0 0.0	15.86 20.82 5.0 31.3	17.36 26.54 9.2 52.9	20.89 35.68 14.8 70.8	22.92 42.52 19.6 85.5	24.17 47.30 23.1 95.7	25.27 49.35 24.1 95.3	25.77 49.53 23.8 92.2	25.78 49.53 23.8 92.1	25.78 49.54 23.8 92.2	25.80 49.55 23.8 92.1	25.81 49.56 23.8 92.0	25.81 49.57 23.8 92.1	25.81 49.57 23.8 92.1	25.82 49.58 23.8 92.0	25.82 49.58 23.8 92.0	25.83 49.59 23.8 92.0
Municipal Solid Waste? AE02001 18.36 WN01 18.36 Difference 0.0 % Difference 0.0	d Waste 18.36 18.36 0.0	19.03 19.03 0.0 0.0	19.44 19.44 0.0	19.64 19.64 0.0 0.0	25.36 23.10 -2.3 -8.9	27.35 27.35 0.0 0.0	27.63 27.63 0.0 0.0	28.01 28.01 0.0 0.0	28.53 28.53 0.0 0.0	29.19 29.19 0.0 0.0	30.00 30.00 0.0 0.0	30.96 30.95 0.0 0.0	32.08 32.10 0.0 0.1	32.59 32.59 0.0 0.0	32.74 32.74 0.0 0.0	32.88 32.88 0.0 0.0	33.26 33.26 0.0 0.0	33.51 33.51 0.0 0.0	33.65 33.65 0.0 0.0	33.81 33.80 0.0 0.0	33.96 33.94 0.0 -0.1
Biomass AEO2001 WN01 Difference	10.77 10.57 -0.2 -1.9	13.62 13.39 -0.2 -1.7	17.06 16.97 -0.1	14.27 14.20 -0.1	15.07 15.02 -0.1 -0.3	17.27 18.35 1.1 6.3	19.41 19.24 -0.2 -0.9	19.77 19.72 -0.1	20.51 20.60 0.1 0.4	20.57 20.55 0.0 -0.1	21.59 22.01 0.4 1.9	21.66 22.39 0.7 3.4	21.71 22.76 1.1 4.8	22.52 22.92 0.4 1.8	22.65 22.82 0.2 0.8	23.21 22.67 -0.5 -2.3	23.25 22.20 -1.1 -4.5	23.10 24.75 1.7 7.1	22.64 24.79 2.2 9.5	22.47 23.93 1.5 6.5	22.15 22.22 0.1 0.3
Solar Thermal AEO2001 WN01 Difference % Difference	0.89 0.0 0.0	0.89 0.0 0.0	0.90 0.90 0.0 0.0	0.91 0.91 0.0	0.94 0.94 0.0 0.0	0.96 0.96 0.0	0.98 0.0 0.0	1.01 0.0 0.0	1.05 1.05 0.0 0.0	1.08 0.0 0.0	11.11 0.0	1.13 1.13 0.0 0.0	1.15 1.15 0.0 0.0	1.17	1.21 1.21 0.0 0.0	1.24 1.24 0.0 0.0	1.26 1.26 0.0 0.0	1.29 1.29 0.0 0.0	1.31 1.31 0.0 0.0	1.34 1.34 0.0 0.0	1.37 1.37 0.0 0.0
Solar Photovoltaic AEO2001 WN01 Difference	0.04 0.04 0.0 0.0	0.05 0.05 0.0	0.07 0.07 0.0 0.0	0.11 0.0 0.0	0.15 0.0 0.0 0.0	0.20 0.20 0.0 0.0	0.26 0.26 0.0 0.0	0.31 0.31 0.0 0.0	0.37 0.37 0.0 0.0	0.44 0.0 0.0	0.51 0.51 0.0 0.0	0.59 0.59 0.0 0.0	99.0 9.0 0.0	0.74 0.0 0.0 0.0	0.83 0.0 0.0	0.92 0.92 0.0 0.0	1.01 0.0 0.0	1.10 0.0 0.0	1.18 1.18 0.0 0.0	1.27 1.27 0.0 0.0	1.36 1.36 0.0 0.0
Wind AEO2001 WN01 Difference % Difference	5.18 5.18 0.0 0.0	6.62 6.62 0.0 0.0	7.73 7.73 0.0	8.33 8.33 0.0 0.0	8.88 9.77 0.9	9.42 12.61 3.2 33.9	10.00 27.14 17.1 171.4	10.62 36.85 26.2 247.0	11.26 46.63 35.4 314.1	11.94 58.29 46.4 388.2	12.33 69.18 56.9 461.1	12.52 81.95 69.4 554.6	12.71 96.81 84.1 661.7	12.78 114.90 102.1 799.1	12.78 130.60 117.8 921.9	12.84 148.90 136.1 1059.7	12.91 165.60 152.7 1182.7	12.93 186.20 173.3 1340.1	12.94 201.00 2 188.1 1453.3 1	13.02 230.90 2 217.9 1673.4	13.10 251.20 238.1 1818
TOTALS AEO2001 WN01 Difference	48.63 48.43 -0.2	53.77 53.54 -0.2	58.79 58.70 -0.1	56.86 56.79 -0.1	63.96 62.54 -1.4 -2.2	71.06 80.29 9.2 13.0	75.64 101.79 26.2 34.6	80.61 121.58 41.0 50.8	84.64 139.70 55.1 65.1	87.39 156.85 69.5 79.5	90.81 172.16 81.4 89.6	92.63 186.5 93.9 101.4	94.09 203.0 108.9 115.8	95.58 221.9 126.3 132.1	96.01 237.8 141.7 147.6	96.90 256.2 159.3 164.4	97.50 272.9 175.4 179.9	97.74 296.4 198.7 203.3	97.54 311.5 214.0 219.4	97.73 340.8 243.1 248.7	97.77 359.7 261.9 267.9
Excludes cogeneration From AEO2001 Table A17 Includes landfill gas	neration 1 Table 1 1 gas	117																			

Table WN-3. Case 6 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3WN. Total Carbon E	WN.	Total	Carl	on E	missi	ions (Mt/a): C	se 6	and ≀	missions (Mt/a): Case 6 and AEO2001	2001^{1}									
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum																					
AEO2001	631.2	648.0	661.7	672.4	683.5	695.5	707.6	719.5	730.3	740.5	750.6	760.3	769.5	780.8	792.4	803.7	815.0	825.4	835.4	845.5	856.1
Difference	0.0	0.0			0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	-0.4							6.0-
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1							-0.1
Natural Gas																					
AEO2001	265.4	272.1			289.2	291.9	296.2	299.7	303.1	306.1	309.8	312.9	316.6	319.9	323.4		331.0				343.3
WN01 Difference	265.4	2/2.1	4.6/7 0.0	0.0	289.3	0.0	296.1 -0 1	0.0	303.2 0.1	306.1 0.0	309.9	313.0 0.1	317.0 0.4	320.2	323.8 0.4		331.0	334.7 0.6	. 87.8 . 0.6	242.8 2.8	343.9
% Difference	0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0				0.2
Coal																					
AEO2001	68.9	0.69	68.7	69.4	69.4	9.69	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.5	69.5	69.4	69.5	69.5	69.5	69.5	9.69
WN01	68.9	0.69	68.7	69.4	69.4	9.69	69.5	69.5	69.5	69.4	69.5	69.4	69.5	69.4	69.5	69.4	69.4	69.4	69.4	69.4	69.5
Difference % Difference	0.0	0.0	0:0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- - - - - - - -	0.0	0.0	9 - 0 - 1	- - - - -		- - - - - - - - - - - - - - - - - - -	ဂု ဝှ
Other																					Ī
AFO2001	0 0	0.0	0 0	0	0	0.1	0.1	0 1	0.1	0	0.1	0 1	0.1	0.1	0.1	0.1	0.1	0.1	0 1	0	0 1
WN01	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity																					
AEO2001	569.8	587.4	601.6	615.6	625.4	633.1	639.6	653.2	661.6	667.8	679.1	687.1	695.7	706.3	715.5	727.5	735.1	746.5	753.7	761.5	771.5
Difference	0.0	0.1				-1.7	4.5		-9.1	-9.5	-11.5	-13.3			-18.5	-20.6		-25.2			-31.9
% Difference	0.0	0.0				-0.3	-0.7		-1.4	-1.4	-1.7	-1.9			-2.6	-2.8		-3.4			-4.1
TOTAL																					
AEO2001	1535	1577	1611	1643	1668	1690	1713	1742	1765	1784	1809	1830	1851	1877	1901	1928	1951	1976	1996	2017	2041
W.N01	1555	//51	1611	1643	1668	1688	1/08	1/35	50/1	17/4	16/1	1816	1835	1858	1887	1907	9261	1950	1969	1987	2008
Difference % Difference	0.0	0.0	0.0	0.0	0.0	-2.0 -0.1	-5.0 -0.3	-/.0 -0.4	-10.0 -0.6	-10.0 -0.6	-12.0	-14.0 -0.8	-16.0 -0.9	-19.0 -1.0	-19.0 -1.0	-21.0	-22.0	-26.0 -1.3	-2/.0 -1.4	-30.0 -1.5	-53.0 -1.6
From AEO2001 Table A19	Table 4	119																			
1007071	Table																				

Table AL-1. Case 7 Capacity from Renewable Technologies and AEO2001

Appendix 1AL. Electric Generators' Capacity of Renewable Technologies ¹	1AL	. Elec	tric (Gene	rator	s, Ca	pacit	y of]	Rene	wabl	e Tec	hnol	ogies	¹ (GW):		Case	7 and	1 AE(Case 7 and AEO2001	[2	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal AEO2001	2.93	2.93	2.93	2.93	2.88	3.15	3.34	3.79	4.05	4.21	4.34	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41
Difference % Difference	0.0	0.0	0.0	0.0	0.0	0.6	35.9	1.9	2.6	3.1	3.4	4.2	4.4 99.3	4.5	4.6 103.2	4.6 104.3	4.6	4.7	4.7 106.6	4.7	4.8
Municipal Sol	Solid Waste	te³																			
AEO2001 AL01 Difference % Difference	2.64 2.64 0.0	2.76 2.76 0.0	2.78 2.78 0.0	2.81 2.83 0.0	3.54 3.24 -0.3	3.80 3.84 0.0	3.84 3.89 0.1	3.90 3.97 0.1	3.98 4.07 0.1	4.08 4.19 0.1	4.20 4.57 0.4 8.8	4.34 4.80 0.5	4.51 4.99 0.5 10.6	4.53 5.03 0.5	4.55 5.07 0.5 11.4	5.11 0.5 11.8	4.64 5.19 0.6	4.66 5.22 0.6	4.68 5.26 0.6	4.70 5.29 0.6	4.72 5.32 0.6
Biomass	9	2.0	2.0	3	5	1	C: 1	0.1	C:4	7	0.0	0.01	0.01	0.11	11:1	0.11.0		0.71	F.71	0.71	17.7
AEO2001 AL01	1.53	1.54	1.60	1.62	1.66	1.68	1.71	1.76 1.89	1.84 2.00	1.93 2.14	2.29	2.17 2.46	2.32	2.32	2.32	2.33	2.37	2.37	2.37	2.37	2.37
Difference % Difference	0.0	0.0	0.0	0.0	3.0	4.2	5.8	7.4	8.7	10.9	12.3	0.3 13.4	0.3 13.8	0.4 15.5	17.2	18.9	0.5	20.7	21.5	22.4	23.2
Solar Therma	_																				
AEO2001 AL01 Difference % Difference	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.33 0.33 0.0 0.0	0.34 0.34 0.0 0.0	0.35 0.36 0.0 2.9	0.35 0.37 0.0 5.7	0.36 0.38 0.0 5.6	0.37 0.40 0.0 8.1	0.38 0.46 0.1 21.1	0.39 0.52 0.1 33.3	0.40 0.58 0.2 45.0	0.40 0.63 0.2 57.5	0.41 0.69 0.3 68.3	0.42 0.74 0.3 76.2	0.43 0.80 0.4 86.0	0.44 0.86 0.4 95.5	0.44 0.89 0.5 102.3	0.45 0.92 0.5 104.4	0.46 0.96 0.5 108.7	0.47 0.99 0.5 110.6	0.48 1.03 0.6 114.6
Solar Photovoltaic	oltaic																				
AEO2001 AL01 Difference % Difference	0.01 0.01 0.0 0.0	0.02 0.02 0.0 0.0	0.03 0.03 0.0	0.05 0.05 0.0 0.0	0.06 0.07 0.0 16.7	0.09 0.00 0.0	0.11 0.12 0.0 9.1	0.13 0.14 0.0 7.7	0.15 0.21 0.1 40.0	0.18 0.28 0.1 55.6	0.21 0.35 0.1 66.7	0.24 0.44 0.2 83.3	0.27 0.52 0.3 92.6	0.30 0.61 0.3 103.3	0.33 0.70 0.4 112.1	0.37 0.79 0.4 113.5	0.40 0.87 0.5 117.5	0.44 0.96 0.5 118.2	0.47 1.04 0.6 121.3	0.51 1.12 0.6 119.6	0.54 1.20 0.7 122.2
Wind	C	C.		2	0	7		4				Q.				i i	1	i i	C C	i d	i,
AEO2001 AL01 Difference % Difference	2.76 0.0 0.0	3.53 0.0 0.0	3.80 0.0 0.0	4.28 0.3 6.7	5.02 0.8 19.0	6.29 1.9 42.0	4.65 10.69 6.0 129.9	4.89 13.93 9.0 184.9	5.14 17.50 12.4 240.5	20.98 15.6 287.8	25.71 20.2 366.6	5.58 32.35 26.8 479.7	38.75 33.1 583.4	5.67 42.81 37.1 655.0	5.67 47.80 42.1 743.0	51.95 46.3 811.4	58.47 52.7 920.4	5.73 64.63 58.9 1027.9	5.73 66.79 61.1 1065.6	5.76 69.79 64.0 11111.6	74.80 69.0 1194.1
TOTALS		:					2	2	,	000		-	0	1	i i	0	9	7001	0	0	0001
AEU2001 AL01 Difference % Difference	10.20 10.20 0.0 0.0	11.11 11.11 0.0 0.0	11.47 11.47 0.0	11.76 12.11 0.4 3.0	12./1 13.32 0.6 4.8	13.50 16.13 2.6 19.5	14.01 21.43 7.4 53.0	14.84 26.05 11.2 75.5	30.89 15.4 98.8	16.20 35.45 19.3 118.8	16.70 41.22 24.5 146.8	17.14 49.33 32.2 187.8	17.59 56.38 38.8 220.5	17.65 60.77 43.1 244.3	17.71 66.05 48.3 273.0	17.82 70.49 52.7 295.6	17.30 59.3 329.7	18.06 83.67 65.6 363.3	18.12 86.04 67.9 374.8	18.22 89.24 71.0 389.8	18.30 94.46 76.2 416.2
Excludes cogeneration From AEO2001 Table A17	eneratio 01 Tabl	n e A17																			
Includes landfill gas	till gas																				

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Table AL- 2. Case 7 Generation from Renewable Technologies and AEO2001

Appendix 2AL.	2AL.	Elec	Electric Genera	ener		tors Generation from Kenewable	leran	11 1101	(T III)	, CII C 11	anıc		9		·(= :: =))			Case / and Aleccor	
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Geothermal	0			9							1		i d								
AEO2001 AL01 Difference	13.39	13.56	13.59	13.60	13.56	15.86 20.87 5.0	26.78	36.09	43.49	24.17 48.91 24.7	51.95	25.77 59.26 33.5	60.41	61.30	25.80 61.73 35.9	25.81 62.16 36.4	25.81 62.46 36.7	25.81 62.75 36.9	63.05	25.82 63.35 37.5	63.65
% Difference	0.0	0.0	0.0	1.4	7.8	31.6	54.3	72.8	89.7	102.4	105.6	130.0	134.3	137.8	139.3	140.8	142.0	143.1	144.2	145.4	146.4
Municipal Solid Waste	d Waste																				
AEO2001 AL01	18.36	19.03 19.03	19.44 19.44	19.64 19.74	25.36 22.95	27.35	27.63 28.01	28.01 28.49	28.53 29.16	29.19	30.00	30.96	32.08	32.59 36.40	32.74	32.88	33.26 37.43	33.51	33.65 38.01	33.81 38.24	33.96
Difference % Difference	0.0	0.0	0.0	0.1	-2.4 5.4	0.3	0.4	0.5	9.0	0.8	2.8	3.5	3.7	3.8	3.9	4.1	4.2	4.3	4.4	4.4	4.5
Die Difference	0.0	0.0	9.0	J. O.	C.7-]	†	1.7	7:4	7.	7.6	711.7	C.11	/	0.71	+ .71	C.71	17.7	0.61	1.61	C.C.1
BIOMASS AFO2001	1077	13.62	17.06	14 27	15.07	17 27	19 41	19 77	20.51	20.57	21 59	2166	21.71	22 52	22 65	23.21	23.25	23.10	22 64	72 47	22 15
AL01	10.45	14.40	15.56	14.34	15.16	18.28	19.22	20.59	21.70	25.56	27.97	28.35	26.03	23.19	21.99	21.45	21.92	19.53	19.51	19.59	19.31
Difference	-0.3	0.8	-1.5	0.1	0.1	1.0	-0.2	0.8	1.2	5.0	6.4	6.7	4.3	0.7	-0.7	-1.8	-1.3	-3.6	-3.1	-2.9 5.5	-2.8
% Difference	-3.0	2.7	×.×-	0.0	0.0	2.8	-1.0	4.T	٥. م	74.3	79.0	30.9	9.91	3.0	6.2-	0./-	٠.٠'	c.cl-	-13.8	-17.8	-17.8
Solar Thermal																					
AEO2001	0.89	0.89	0.90	0.91	0.94	0.96	0.98	1.01	1.05	1.08	1.11	1.13	1.15	1.17	1.21	1.24	1.26	1.29	1.31	1.34	1.37
ALU1 Difference	0.0	0.0	0.00	0.00	0.99	1.04	0.1	0.14	0.40	0.1	0.8	1.0	2.30	1.00	1.04	2.00	2.0	2.5	2.2	5.05 2.3	2.4
% Difference	0.0	0.0	0.0	2.2	5.3	8.3	10.2	12.9	33.3	53.7	72.1	88.5	105.2	122.2	134.7	148.4	154.8	159.7	166.4	170.9	175.2
Solar Photovoltaic	Itaic																				
AEO2001	0.04	0.05	0.07	0.11	0.15	0.20	0.26	0.31	0.37	0.44	0.51	0.59	99.0	0.74	0.83	0.92	1.01	1.10	1.18	1.27	1.36
ALUI Difference	40.0	0.0	0.0	0.12	0.16	0.0	0.0	0.34	0.47	0.03	0.78	0.97	0.5	1.33	56.1	0.8	1.91	2.08	2.20	4.7 C 1	2.02
% Difference	0.0	0.0	0.0	9.1	6.7	10.0	7.7	9.7	27.0	43.2	52.9	64.4	74.2	7.67	84.3	88.0	89.1	89.1	91.5	92.1	92.6
Wind																					
AEO2001	5.18	6.62	7.73	8.33	8.88	9.42	10.00	10.62	11.26	11.94	12.33				12.78	12.84	12.91	12.93			13.10
AL01 Difference	5.18 0.0	79.9	0.0	9.08 0.8	2 4	14.91	30.21	41.61 31.0	54.39 43.1	66.61 54.7	83.76				154.8	171 4	2 0C.012 197 6	236.20			00.677
% Difference	0.0	0.0	0.0	9.0	27.0	58.3	202.1	291.8	383.0	457.9	579.3	765.8	939.3	1054.9	1211.4	334.6	1530.5	1726.8	1794.1	1877.0	2030
TOTALS																					
AEO2001	48.63	53.77		56.86	63.96	71.06	75.64	80.61	84.64	87.39	90.81	92.63	94.09	95.58	96.01	96.90	97.50	97.74	97.54	97.73	97.77
AL01	48.31	54.55		58.00	64.48	_		128.26	150.61	173.35	199.14	233.6	257.8	272.4	292.4	309.6	337.4	361.7	371.4	384.7	406.8
Difference % Difference	-0.5 -0.5	0.0 2	-1.5 -2.6	1.1	0.0 8.0			4/./ 59.1	0.00	80.0 98.4	116.3	150.9	105.7	1,0.8	204 5	212.7	239.9 246.1	203.9	2808	280.9	3161
	;	;	i	i	2			:	:	-			2					2	2	5	
Excludes cogeneration	neration	1																			
From AECZ001 Table A17 Procludes landfill gas	1 Lable 11 gas	A1/																			

Table AL-3. Case 7 Total Carbon Emissions (Mt/a) and AEO2001

Appendix 3AL. Total Carbon E	3AL.	Fotal	Carb		missi	ons (I	Mt/a)	; Ca	se 7 a	und A	missions (Mt/a): Case 7 and AEO2001	0011									
	2000	2001	2002	2003	2004	2002	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Petroleum AEO2001 AL01 Difference % Difference	631.2 631.2 0.0 0.0	648.0 648.0 0.0 0.0	661.7 661.7 0.0 0.0	672.4 672.4 0.0 0.0	683.5 683.6 0.1 0.0	695.5 695.5 0.0 0.0	707.6 707.8 0.2 0.0	719.5 720.1 0.6 0.1	730.3 731.3 1.0 0.1	740.5 742.2 1.7 0.2	750.6 752.7 2.1 0.3	760.3 762.8 2.5 0.3	769.5 772.4 2.9 0.4	780.8 783.8 3.0 0.4	792.4 795.7 3.3 0.4	803.7 802.2 -1.5 -0.2	815.0 813.2 -1.8 -0.2	825.4 822.7 -2.7 -0.3	835.4 833.8 -1.6 -0.2	845.5 843.2 -2.3 -0.3	856.1 854.3 -1.8
Natural Gas AEO2001 AL01 Difference % Difference	265.4 265.4 0.0 0.0	272.1 272.1 0.0 0.0	279.4 279.4 0.0 0.0	285.3 285.4 0.1 0.0	289.2 289.5 0.3 0.1	291.9 292.5 0.6 0.2	296.2 294.0 -2.2 -0.7	299.7 294.8 -4.9 -1.6	303.1 295.4 -7.7 -2.5	306.1 295.1 -11.0	309.8 295.6 -14.2 -4.6	312.9 294.7 -18.2 -5.8	316.6 295.2 -21.4 -6.8	319.9 295.1 -24.8 -7.8	233.4 295.0 -28.4 -8.8	327.5 299.9 -27.6 -8.4	331.0 300.1 -30.9 -9.3	334.1 300.7 -33.4 -10.0	337.2 299.2 -38.0 -11.3	340.0 299.7 -40.3 -11.9	343.3 299.5 -43.8 -12.8
Coal AEO2001 AL01 Difference % Difference	68.9 68.9 0.0 0.0	69.0 69.0 0.0 0.0	68.7 68.7 0.0 0.0	69.4 69.5 0.1 0.1	69.4 69.6 0.2 0.3	69.6 69.9 0.3 0.4	69.5 70.0 0.5 0.7	69.5 70.2 0.7 1.0	69.5 70.3 0.8 1.2	69.4 70.3 0.9 1.3	69.5 70.5 1.0 1.4	69.4 70.5 1.1 1.6	69.5 70.7 1.2 1.7	69.5 70.7 1.2 1.7	69.5 70.8 1.3 1.9	69.4 70.7 11.3 11.9	69.5 70.8 1.3 1.9	69.5 71.0 1.5 2.2	69.5 71.0 1.5 2.2	69.5 71.0 1.5 2.2	69.6 71.2 1.6 2.3
Other AEO2001 AL01 Difference % Difference	0.0	0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0	0.1 0.0 0.0
Electricity AEO2001 AL01 Difference % Difference	569.8 569.8 0.0 0.0	587.4 587.2 -0.2 0.0	601.6 601.7 0.1 0.0	615.6 614.7 -0.9 -0.1	625.4 623.6 -1.8 -0.3	633.1 628.6 -4.5 -0.7	639.6 626.9 -12.7 -2.0	653.2 635.2 -18.0 -2.8	661.6 640.4 -21.2 -3.2	667.8 644.5 -23.3 -3.5	679.1 654.5 -24.6 -3.6	687.1 666.4 -20.7 -3.0	695.7 678.2 -17.5	706.3 693.2 -13.1 -1.9	715.5 704.7 -10.8 -1.5	727.5 718.3 -9.2 -1.3	735.1 724.8 -10.3 -1.4	746.5 732.5 -14.0 -1.9	753.7 736.9 -16.8 -2.2	761.5 746.9 -14.6 -1.9	771.5 753.6 -17.9
TOTAL AEO2001 AL01 Difference % Difference	1535 1535 0.0 0.0	1577 1576 -1.0	1611 1612 1.0 0.1	1643 1642 -1.0	1668 1666 -2.0 -0.1	1690 1687 -3.0 -0.2	1713 1699 -14.0 -0.8	1742 1720 -22.0 -1.3	1765 1737 -28.0 -1.6	1784 1752 -32.0 -1.8	1809 1773 -36.0 -2.0	1830 1795 -35.0 -1.9	1851 1817 -34.0 -1.8	1877 1843 -34.0 -1.8	1901 1866 -35.0 -1.8	1928 1891 -37.0 -1.9	1951 1909 -42.0 -2.2	1976 1927 -49.0 -2.5	1996 1941 -55.0 -2.8	2017 1961 -56.0 -2.8	2041 1979 -62.0 -3.0
'From AEO2001 Table A19	Table 1	119																			

Table AL-4. Case 7 Fuel Consumption by Sector and Fuel Type and AEO2001

Table 6AL-5. Fuel Consumption	5. F	nel C	onsu	mpti	on by		Sector and		Fuel Type ¹), ad	(Quads):		Case 7 a	and A	AEO200	001					
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential Petroleum	.oleum																				
AEO2001	1.44	1.50	1.49	1.48	1.45	1.42	1.40	1.37	1.35	1.32	1.29	1.28	1.27	1.26	1.26	1.24	1.24	1.22	1.22	1.21	1.21
AL01 Difference	1.44	000	0.0	0.0	0.0	0.0	0.40	0.0	0.0	0.0	0.0	0.0	67.1	87:T	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Difference	0	0	0	0	0	0	0	0	0	0	-	-	7	7	-	2	7	7	2		c
Residential Nat	Natural Gas																				
AEO2001	4.97	5.14	5.26	5.35	5.43	5.46	5.51	5.55	5.61	5.65	5.69	5.75	5.82	5.87	5.93	5.99	90.9	6.11	6.17	6.23	6.30
AL01	4.97	5.14	5.26	5.35	5.43	5.47	5.43	5.39	5.36	5.30	5.25	5.21	5.19	5.14	5.10	5.07	5.04	4.99	4.96	4.93	4.91
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.3	4.0-	-0.4 o	-0.5	-0.6	-0.7	-0.8 -7	-0.9	-1.0	-1.1	-1.2	-1.3	4: 1-
% Difference	0	0	0	0	0	0	-	5-	4	9	×ρ	6-	-11	-12	-14	-15	-17	-18	-20	-21	-22
Residential Coa	L																				
AEO2001	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
AL01	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Difference % Difference	0.0	0.0	0.0	0:0	0:0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0:0	0:0	0.0
Desidential Flori	7 7																				
Kesidentiai Electricity	ctricity								i i	, ,							,		3	C	0
AEO2001	3.96	4.06	4.17	4.27	4.39	4.50	4.58	4.67	87.4	4.86	4.96	5.04	5.14	5.21	5.28	5.37	5.46	5.53	5.61	5.70	5.80
Difference	0.30	00.4	1.0	7.0	0+.+	00.4	5.0	70.4 0 0	† † C	0.4	16.4	0.0	0.0	0.0	07:50	0.0	0.50	0.50	0.00	0.19	0.72
% Difference	0.0	0.0	0.0	0	0	0.0	3 7	- 5.5	- 5	- 5	- 5.5	? 7		0.0	0.0	0.0	- 1	- 0.0	1	7.7	2
Commercial Petroleum	roleum																				
AEO2001	0.59	0.63	0.64	0.65	0.65	99 0	99 0	99 0	190	290	0.67	29.0	0.67	0.67	290	190	0.67	990	990	99 ()	99 0
AL01	0.59	0.63	0.64	0.65	0.65	99.0	99.0	0.67	0.68	69.0	0.70	0.71	0.72	0.74	0.75	0.76	0.77	0.78	0.79	0.80	0.80
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
% Difference	0	0	0	0	0	0	0	7	1	3	4	9	7	10	12	13	15	18	20	21	21
Commercial Natural Gas	tural Ga	25																			
AEO2001	3.27	3.39	3.52	3.62	3.68	3.71	3.75	3.79	3.82	3.85	3.88	3.92	3.96	3.99	4.02	4.05	4.07	4.09	4.11	4.12	4.13
AL01	3.27	3.39	3.52	3.62	3.68	3.72	3.69	3.66	3.62	3.57	3.52	3.48	3.44	3.40	3.35	3.30	3.24	3.19	3.13	3.07	3.01
Difference	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.2	-0.3	-0.4	-0.4	-0.5	9.0-	-0.7	8.0-	8.0-	6.0-	-1.0	-1:1	-1:1
% Difference	0	0	0	0	0	0	-5	<u>.</u> -	ς.	-7	6-	-11	-13	-15	-17	-19	-20	-22	-24	-25	-27
Commercial Coal	L																				
AEO2001	90.0	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	80.0	80.0	80.0	0.08
AL01	90.0	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0:0	0.0
% Difference	0	0	0	0	О	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial Electricity	etricity ²																				
AEO2001	3.78	3.90	4.03	4.13	4.23	4.35	4.45	4.57	4.68	4.78	4.89	4.98	5.08	5.17	5.25	5.32	5.39	5.45	5.51	5.56	5.61
AL01 Difference	5.78	3.90 0.0	4.03	4.13	67.4	4.35	4.43 0.0	4.54 4.00	4.66	/ / .4	4.86	/6.4 0.0	2.07	9.16	0.0	0.0	24.5	000	7.5.7	5.64 0.1	0.71
% Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.0	2.2

Table AL-4 Cont'd. Case 7 Fuel Consumption by Sector and Fuel Type and AEO2001

9.55 9.67 9.82 9.95 10.07 10.23 10.24 10.69 10.85 11.06 11.14 11.21 11.56 11.64 9.55 9.67 9.82 9.95 10.07 10.23 10.61 10.61 10.91 10.91 10.94 10.99 10.98 11.16 11.17 11.18 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.19 11.10	9.55 9.67 9.82 9.95 10.00 10.23 10.43 10.44 10.64 10.65 10.68 11.06 10.83 11.00 11.14 11.28 11.30 11.15 11.24 11.28 11.30 11.15 11.14 11.28 11.30 11.15 11.14 11.28 11.30 11.15 11.14 11.28 11.30 11.15 11.14 11.28 11.30 11.15 11.15 11.28 11.30 11.15 11.15 11.28 11.30 11.15 11.28 11.30 11.15 11.20 11.14 11.28 11.30 11.15 11.15 11.11 11.21 11.13 11.21 11.21 11.20 11.20 11.20 11.20 11.20 11.20 11.20 11.20 11.15 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.21 11.	955 967 982 995 1007 1023 1034 1044 1055 1106 1085 1109 1114 1128 1139 1151 1164 1128 1199 11164 1128 1139 1151 1164 1128 1139 1151 1164 1128 1139 1151 1164 1128 1139 1151 1164 1128 1139 1151 1164 1128 1139 1151 1164 1128 1139 1151 1164 1138 1139 1151 1164 1138 1139 1151 1164 1138 1139 1151 1164 1138 1139 1151 1164 1139 1151 1164 1139 1151 1164 1139 1151 1164 1139 1151 1164 1139 1151 1164 1139 1151 1164 1139 1151 1154 1139 1154 1139 1151 1154 1139 1151 1154 1154 1154 1154 1154 1154 115	L-5 c	Table 6AL-5 cont'd. Fuel Consumption by Sector and Fuel Type (Quads):	Fuel	Cons	umpt	ion b	y Sec	tor a	nd Fu	uel Ty	ype ¹ (Quad	ls): (Case	7 and	Case 7 and AEO2001	2001	2017	2018	2019	2020
955 967 98 995 1007 10.23 10.34 10.44 10.55 10.65 10.99 11.14 11.28 11.39 11.95 11.16 11.12 9.55 9.67 9.82 9.95 10.05 10.26 10.99 10.99 10.99 11.99 11.09 11.02 11.16 11.22 11.16 11.12 11.16 11.22 3 -4 -0.4 <th>955 967 98 995 1007 10.23 10.34 10.44 10.55 10.67 10.94 11.14 11.28 11.39 11.95 11.14 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.52 11.64 11.52 11.64 11.52 11.62 11.12 11.74 11.75 11.82 11.64 11.22 11.74 11.82 11.64 11.22 11.75 11.82 11.61 11.12 11.75<th>982 995 1007 1023 1034 1044 1055 1063 1069 1085 1100 1114 1128 1139 1151 1164 1160 00 0 0 0 0 0 0 1 1 0 1 0 1 0 1 0 1</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th>	955 967 98 995 1007 10.23 10.34 10.44 10.55 10.67 10.94 11.14 11.28 11.39 11.95 11.14 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.22 11.54 11.52 11.64 11.52 11.64 11.52 11.64 11.52 11.62 11.12 11.74 11.75 11.82 11.64 11.22 11.74 11.82 11.64 11.22 11.75 11.82 11.61 11.12 11.75 <th>982 995 1007 1023 1034 1044 1055 1063 1069 1085 1100 1114 1128 1139 1151 1164 1160 00 0 0 0 0 0 0 1 1 0 1 0 1 0 1 0 1</th> <th></th>	982 995 1007 1023 1034 1044 1055 1063 1069 1085 1100 1114 1128 1139 1151 1164 1160 00 0 0 0 0 0 0 1 1 0 1 0 1 0 1 0 1																					
1004 10.26 10.33 10.44 10.66 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00	10.04 10.26 10.33 10.43 10.64 10.76 10.87 10.98 11.11 11.21 11.25 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.04 10.27 10.35 10.44 10.65 10.74 10.83 10.89 11.09 11.15 11.1	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6 6	4 4	9.55 9.55	9.67 9.67	9.82			10.23 10.26	10.34 10.39			10.63 10.68	10.69 10.76	10.85 10.91	11.00	11.14	11.28 10.98	11.39	11.51 11.16	11.64	11.77
1004 10.26 10.33 10.43 10.45 10.65 10.74 10.83 10.84 10.61 10.76 10.87 10.98 11.11 11.12 11.14 11.75	1004 1026 1033 1043 1064 1076 1087 1098 11.11 11.21 11.35 1147 11.50 11.76 11.88 12.00 12.11 12.22 10.04 10.05 10.05	10.33 10.43 10.61 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.35 10.46 10.65 10.74 10.83 10.89 11.10 11.12 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.35 10.46 10.65 10.74 10.83 10.89 11.10 11.13 11.21 11.41 11.70 11.82 11.96 11.96 11.96 12.10 1.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.1			0.0	0.1	0.1	-0.1	-0.2	-0.3	-0.4	-0.4	-0.4	-0.4
10.04 10.26 10.33 10.44 10.61 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.04 10.25 10.35 10.46 10.65 10.74 10.83 10.89 11.00 11.05 11.13 11.21 11.41 11.70 11.81 11.70 11.82 11.96 11.96 11.90 11.9	10.04 10.26 10.33 10.44 10.65 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.04 10.05 10.06 10.06 10.06 10.07 10.03 10.089 11.00 11.05 11.13 11.12 11.14 11.70 11.82 11.96 11.96 11.96 11.10 11.10 11.82 11.96 11.96 11.10 11.	10.33 10.44 10.61 10.76 10.87 10.98 11.11 11.21 11.21 11.31 11.51 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.50 10.60 10.60 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0		0	0	0	0			0	0			0	-	-	7	-5	-3	-3	-3	4	4-
10.04 10.26 10.33 10.44 10.61 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.04 10.27 10.35 10.44 10.65 10.74 10.83 10.89 11.11 11.21 11.35 11.47 11.70 11.88 12.00 12.11 12.22 10.04 10.27 10.35 10.44 10.83 10.84 10.81 10.01 10.12 10.13 10.14 11.70 11.82 11.96 11.9	1004 1026 10.33 1043 10.61 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.04 10.27 10.35 10.46 10.65 10.74 10.83 10.89 11.00 11.05 11.13 11.41 11.70 11.88 12.00 12.11 12.22 10.04 10.27 10.35 10.46 10.65 10.74 10.83 10.89 11.00 11.05 11.13 11.41 11.70 11.82 11.96 11.96 12.10 10.10	10.33 10.43 10.61 10.76 10.87 10.98 11.11 11.21 11.35 11.47 11.59 11.76 11.88 12.00 12.11 12.22 10.3	Industrial Natural Gas																				
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2.59 2.62 2.62 2.62 2.62 2.61 -0.1 <th< td=""><td>2.59 2.62 2.62 2.62 2.61 -0.1 <th< td=""><td>2.62</td><td>99.6</td><td>9.83</td><td>10.04</td><td>10.27</td><td>10.35</td><td></td><td></td><td>10.74</td><td>10.83</td><td></td><td>11.00</td><td></td><td>11.13</td><td>11.21</td><td>11.41</td><td>11.70</td><td>11.82</td><td>11.96</td><td>11.96</td><td>12.10</td><td>12.17</td></th<></td></th<>	2.59 2.62 2.62 2.62 2.61 -0.1 <th< td=""><td>2.62</td><td>99.6</td><td>9.83</td><td>10.04</td><td>10.27</td><td>10.35</td><td></td><td></td><td>10.74</td><td>10.83</td><td></td><td>11.00</td><td></td><td>11.13</td><td>11.21</td><td>11.41</td><td>11.70</td><td>11.82</td><td>11.96</td><td>11.96</td><td>12.10</td><td>12.17</td></th<>	2.62	99.6	9.83	10.04	10.27	10.35			10.74	10.83		11.00		11.13	11.21	11.41	11.70	11.82	11.96	11.96	12.10	12.17
0 0 0 0 0 -1 -1 -2 -2 -2 -1	2.59 2.62 2.62 2.62 2.62 2.63 2.64 2.65 2.66 2.66 2.66 2.66 2.66 2.66 2.66 2.67 <td< td=""><td>262 262 262 262 263 261 261 261 261 261 261 261 261 261 261</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td></td><td></td><td>0.0</td><td>0.0</td><td></td><td>-0.1</td><td></td><td>-0.2</td><td>-0.3</td><td>-0.2</td><td>-0.1</td><td>-0.1</td><td>0.0</td><td>-0.1</td><td>-0.1</td><td>-0.2</td></td<>	262 262 262 262 263 261 261 261 261 261 261 261 261 261 261	0.0	0.0	0.0	0.0	0.0			0.0	0.0		-0.1		-0.2	-0.3	-0.2	-0.1	-0.1	0.0	-0.1	-0.1	-0.2
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3.78 3.83 3.85 3.90 3.97 4.03 4.08 4.13 4.18 4.23 4.27 4.33 4.40 4.47 4.53 4.60 4.66 4.74 3.78 3.81 3.82 3.80 3.97 4.03 4.08 4.13 4.18 4.23 4.27 4.33 4.40 4.45 4.53 4.60 4.66 4.74 4.73 3.81 3.82 3.86 3.90 3.95 4.00 4.04 4.10 4.16 4.22 4.29 4.36 4.45 4.45 4.53 4.60 4.66 4.77 4.71 4.83 4.83 4.84 4.84 4.84 4.84 4.84 4.87 4.84 4.87 4.87	3.78 3.83 3.85 3.90 3.97 4.03 4.08 4.13 4.18 4.23 4.27 4.33 4.40 4.47 4.53 4.60 4.66 4.74 5.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	3.85 3.90 3.97 4.03 4.08 4.13 4.18 4.23 4.27 4.33 4.40 4.47 4.53 4.60 4.66 4.74 3.82 3.86 3.90 3.97 4.01 -0.1 -0.1 -0.1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
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